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BRIEFLY TOLD.

OUR CURRENT INSTALLMENT OF THE PROCEEDINGS.—With this number we continue the publication of the proceedings of the recent meeting of the American Association, the current installment containing no less than five of the papers read. The first of these (by Mr. Walton Clark) discussed the equity and policy of meter rentals, a theme that has often caused vigorous discussion between the company and the consumer. Mr. Clark goes very deeply into the ethics of the question, and his treatment of the subject as a whole is stamped with the die of sincerity. And his way out of the difficulty certainly commands the attention of the reader; but it is, as seen in the general preference of the public to take its medicine enveloped in a capsule, a matter of wide belief that the public when served by a corporation, and especially by a corporation that supplies artificial light, has a decided repugnance to anything that looks like more than one fixed charge for the same service. In other words, the public more than likely objects to a meter rent as a naked fact, whereas it would swallow it without any undue or over-grimacing were it enveloped in the capsule, say, of a well graded system of discounts on the gas rate. Under the differential plan, properly and closely worked, each consumer would pay his identical and just proportion of the cost of manufacture and distribution of the gas supplied. To sum up our belief, meter rents are undoubtedly an equitable charge to each consumer, but it would be politic, and also just, to cloak them under the cloth of a varied schedule rate.

Dr. Wilkinson's excellent treatise on lime—a subject beyond doubt as old as the hills—shows how well-matured thought may and does make sermons out of stones. The Doctor has never claimed to be particularly aggressive and progressive, but the fact is, nevertheless, that he is both, and not offensively so. Well posted on his subject—a "posting" that is the result of years of careful study and experiment—he claims nothing that is startlingly new; but some of his modifications of old beliefs are quite as new as many of the "advances" that are put out from time to time by the boldest of the progressive and aggressive. The Doctor's paper was a good one, and his suggestions are sure to set many a man experimenting; but if he shone well in the paper, he sparkled in the discussion—a master of his subject, he was not to be puzzled. Fred Bredel's contribution to the subject was not very prolix, but it was profound; and we take it that the general tenor of the discussion will afford poor comfort to those who contend that oxide purification alone, or unabetted by lime, will increase the illuminating power of the gas so treated. Carbonic acid will never command a large price as an enricher of gas, and by far the weight of authority is with those who concede to oxide the greatest possible virtue as an extractor of sulphur impurities, but who prefer to defeat their old enemy, carbonic acid, by confronting it with a barrier of lime.

Prof. Love's paper is another of the well considered ones, that will bear the renewing of one's acquaintance with in the course of the year, for in his position of umpire over the candle powers of the gases distributed in New York city, that include about all known varieties in vogue, he had exceptional advantage to prepare a true bill, and here we may be pardoned for remarking that it is no longer a question of coal gas or of water gas. The duty of the day and time is to be gas makers,

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first and last. Incandescent electric lighting has done far more toward showing the way in this respect than has been accomplished by any other influence; and so it is that condition, not theory, must be the guide to the gas engineer in selecting the weapon that will best serve his purpose. Again, then, we say, gas is that which is to be conserved, and circumstance must alone determine whether coal gas or water gas or a mixture of the two is to be the correct thing in a given place. Prof. Love's treatise is in his best vein—practical, precise and impartial. Mr. Douglas was unfortunate in having such an unmanageable subject to deal with—not that he did not do it justice, for his well composed paper stands out in evidence of the time, care and trouble given by him to the developing of something of value from a very refractory material. Perhaps the least said about water gas tar, the better it will be for the tar. We live in hope, however, that the skill and ingenuity of the engineers now concerned in its manipulation will bear good fruit, in that out of evil good may come. Secretary-elect Slater's paper, while somewhat out of the beaten track, induces a line of thought that brings us in closer contact with the possibilites in store for the future of lighting by gas. It stamps him as a student, and marks him as a man who will be heard from again in the advanced ranks of his chosen profession.

Next Meeting of the Gas Club of Chicago.—The next meeting of the Gas Club of Chicago will be held on Tuesday, the 24th inst., at 8 o'clock, P.M., at Becker & Jackson's restaurant, corner of Wabash avenue and Lake street. The programme calls for a discussion of topics pertaining to the general welfare of the Club, and the absorption of a good dinner, which will be served by the restaurant folks at $1 per plate. All gas men who happen to be in or near Chicago on the date mentioned will receive a hearty welcome.

Through an oversight the name of Mr. Wm. C. Adams, Superintendent of the City Gas Works, of Richmond, Va., was omitted from the list of those present at the last meeting of the American Association.

A Correction.—Mr. James Somerville, of Indianapolis, Ind., writing under date of November 11th, desires us to say that in his remarks in the discussion on Mr. Nettleton's paper, he was incorrectly reported. The errors occurred in the paragraph at the foot of second column, p. 654, issue of November 9th, and the corrected text is as follows: "I have often amused myself with my specific gravity apparatus by laying my glass globe right upon the scale. The glass globe is as *tight* as human ingenuity can make it, and yet in a few minutes you will generally see the scale gradually go down. What is it doing? The air is going into the globe, and gas is getting out of it. That extraordinary law of *exosmose* is displacing the gas, and it is going out."

Mr. Somerville evidently has the impression that the Journal is responsible for the reports of the proceedings of the American Gas Light Association. In former times such was the case, but by vote, passed at the New York meeting of 1887, the Association decided to take its own report, and that is the practice now observed.

The following letter is published at the request of the writer:

Peoria, Ill., Nov. 10th, 1891.

To the Editor American Gas Light Journal:

Having been permanently cured of the drinking habit by Dr. Keeley's treatment, at Dwight, I ask the returning confidence of our industry.

Your publication of this note may hold up a beacon to others, and will certainly be an act of simple justice to myself.

Very truly,

James R. Smedberg.

The Market for Gas Securities.

There was no change in Consolidated during the week, the opening price to day (Friday) being 99¼–100. Other city shares show no variation from the figures last reported. The notable features of the week in city gas affairs were the reported resignation of Mr. Andrews from the Presidency of the Standard Company, and another edict from the Board of Health, again ordering the works to be closed, this time on the 17th inst. There is not any very great reason for supposing that the works will be shut down, as the Company will have its arrangements made before that day for keeping on.

Over in Brooklyn the situation is much improved, all classes of shares having made a substantial advance. In out-of-town shares the feature was Chicago gas, which sold up to 60 during the week.

[Continued from page 656.]

[Official Report—Revised by the Secretary.]

NINETEENTH ANNUAL MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION.

Held at New York, October 21, 22 and 23, 1891.

First Day—Afternoon Session.

The President introduced Mr. Walton Clark (Phila., Pa.), who read the following paper on

METER RENTS—A QUESTION OF EQUITY AND POLICY.

The equity or policy of the common practice of selling gas to consumers of different volumes, at prices that bring to the seller different profits per 1,000 cubic feet sold, has met with little question. I propose to make some suggestions that have come to my mind in this connection. Its relation to the title of this paper will appear later. Preliminary to my argument I assume certain propositions as generally admitted, viz.: (1), a gas company ordinarily has, and it is to the general interest that it should have, a regulated monopoly of the right to open streets and occupy the subsoil for the purposes of gas supply; (2), its rights have their origin in the citizens of the State; (3), these rights involve peculiar obligations to the public granting them; (4), in common with railroads, and other corporations performing a public service, a gas company is under obligations to make no distinction in its treatment of individuals served by it.

A corporation doing business as a gas manufacturer or common carrier is entitled to an interest on its investment in plant and working capital, the amount depending from complex considerations, which I shall not attempt to analyze; for the limit, whether 5 or 50 per cent., is not material to my argument. Is it entitled to collect upon the investment necessary to the service of any one customer, an interest greater or less than is paid by any other customer upon the investment made in his behalf? Not if the fourth proposition as above is sound. Aside from mere business courtesy, the question of equal treatment can include only the financial question, the doing of a service proportionate to the payment received, and it is evident that the measure of the service is incomplete until consideration has been given to the amount of investment involved.

Obviously, a corporation is not rendering equal service for equal money, if it is collecting from one patron an interest charge to be applied on the investment in behalf of another patron. This principle of the obligation of corporations performing a public service to vary their charges only as the cost of the benefit charged for varies, has had expression in legal decisions. One of the clearest and most to the point, as indicating the duty of railroads in the direction in which they are unquestionably akin to gas and water companies, is by the eminent Judge Baxter, of the Sixth Federal Circuit. In a decision rendered in a suit against the Pennsylvania Railroad Company for damages resulting from a discrimination in charges on coal carriage based upon difference in quantity (all being in carload lots), Judge Baxter, in deciding against the railroad company's right to make the discrimination charged and proven, says:

"A reference to recognized elementary principles will aid in a correct solution of the problem. The defendant is a common carrier by rail. Its road, though owned by the corporation, was nevertheless constructed for public uses, and it is in a qualified sense a public highway. Hence everybody constituting a part of the public for whose benefit it was authorized is entitled to an equal and impartial participation in the use of the faculties it is capable of affording. Freight carried over long distances may be carried at a reasonably less rate per mile than freight transported for shorter distances, *simply because it costs less to perform the service.* For the same reason passengers may be divided into different classes and the price regulated in accordance with the accommodations furnished to each, because it costs less to carry an emigrant, with the accommodation furnished to that class, than it does to carry the occupant of a palace car. It has been held that 20 separate parcels done up in one package, and consigned to the same person, may be carried at a less rate per parcel than 20 parcels of the same character consigned to as many different persons at the same destination; because it is supposed that it costs less to receive and deliver one package containing 20 parcels to one man, than it does to receive and deliver 20 different parcels to as many consignees."

The meaning of this and similar decisions, is plainly that corporations organized to do a public work must so regulate their charges that the net return to them, or the profit they make, shall not vary per unit of service rendered. It is their privilege—more, it is their duty—to collect,

for a unit of product involving greater expenditure than another, a sum beyond the standard charge, representing the additional labor, interest, or other charges going to make up the additional expenditure. With railroads a nice adjustment of the labor item is a matter of some difficulty. The interest and maintenance and repairs items are little affected, except in the case of different classes of passenger business, but at the best only an approximation to the standard demanded by Judge Baxter can be attained. In the gas business, the problem offers little of difficulty. The at once simple and equitable plan is to charge for each 1,000 cubic feet of gas an amount covering its proportion of the items of expense and interest common to the performance of the total service, adding to each bill so made the items peculiar to the individual service.

It needs no demonstration that the cost of gas in the holder, including interest and taxes on the investment at the works, and the salaries of officers (not clerks) will not be affected by the mere number of consumers. It is the volume made, not the number of people to whom sold, that will in any given locality determine these factors in the cost per 1,000 cubic feet sold. It may be questioned whether the investment in distributing mains per 1,000 cubic feet sold, is not greater for the consumer of few thousands than for the consumer of many thousands. A gas company in laying out its mains in the city in which it does business plans to put down its pipes wherever it sees the prospect of getting its legitimate return upon its investment. If it goes elsewhere, it is to make for itself that local popularity which shall tend to the greater security of its investment, and thence to a lower price to its consumers generally. If it makes an extension for an individual consumer to do business that will not pay its proportion of the interest on the general investment, such extension may legitimately be regarded as a service pipe and its cost treated accordingty. It might be claimed that a distant customer, while profitable, involved a greater expenditure to reach than a near customer, and that on this fact the latter might base a claim in equity to a lower price. If such an assertion had force it would carry with it the obligation on the part of the company to so locate its works that no consumer should be at this disadvantage as compared with another; an obvious impossibility. The duty of a company in this direction appears to be to locate its works on the most suitable spot and regard its mains as part of the investment for the general supply, maintenance and interest going into the charge for gas.

These considerations lead me to the belief that no injustice attends the assumption that, per 1000 cubic feet sold, there is no difference in the cost of supplying the consumers of large or small volumes, up to the inlet of the service pipe. Thence, to the outlet of the meter, where the gas passes from the control of the company, the items of cost, viz., service pipe and meter maintenance, and interest, as also the cost of keeping one account, collecting one bill and attending to the complaints of one consumer, are not the same for each unit of volume of gas sold, are readily determinable, and, if our principle is true, are legitimately the subject of a separate charge against the consumer. It may be objected that office rent is an item as large for a consumer of few, as for a consumer of many thousands, and, therefore, if the principle under discussion were carried out, a proportion of it should enter into the fixed charge against the individual consumer. An office in a convenient part of the city supplied, must be rented or owned by the gas company whether the number of consumers is large or small. There is a proportionately small increase in the room necessary to the accounting force, with each increase in the number of consumers commensurate with the amount of work one bookkeeper can do. While this should in principle follow the charge for the bookkeeping, I believe it forms an item too small and difficult of determination to be considered.

It may be objected that the costs of attending to complaints, keeping gas accounts and collecting bills, do not vary in proportion to the number of consumers; because a bookkeeper, now keeping the accounts of say 1,500 consumers, could attend as well to 2,000, and a similar statement may be made of the employees concerned with complaints and collections.

It must be assumed that in any gas office the time of the employees is, practically, entirely occupied at one or another class of work, and that where there is more bookkeeping and collecting work than a given number of clerks can attend to, and less than that number plus one can do, the idle time of the one clerk is put to some good use. That this is so in any well regulated office cannot be doubted. There need be no idle time except that of complaint men waiting a call, a necessary part of their duty, and it seems fair to regard them, and the bookkeepers and collectors, as employed on each account just that proportion of their time that the total number of accounts one man can attend to when fully occupied bears to his full time. Where, as in the smaller offices, one man does several kinds of work, only part chargeable to the individual accounts, this part is easily determinable. To repeat, there appears no difficulty in ascertaining for any works the amount of the charge to be made up of those items of cost which are not dependent on the volume of gas a customer buys, and which must be charged to him as a fixed sum per month (generally called by my title "Meter Rent"), if the principles laid down above are to be carried out. This charge would be to each consumer the same, only to the extent that it covered the items of bookkeeping, printing, collecting, etc. The items of service pipe and meter maintenance and interest would vary with the sizes of each and the length of the former. The details of the determination and recording of such charges offer no difficulties, as a moment's thought will convince anyone familiar with gas accounting. The approximation to absolute equity could be very close.

What would be the effect of the adoption of this principle in our business? First, on the consumer, what? The purchaser of the average volume of gas at average meter and service pipe costs, would not be affected, except in the form of his bill. He would be charged a "meter rent" covering the items above discussed, and a correspondingly smaller amount for his gas, the total being the same as under the present plan. The consumer of a volume less than the average would pay a somewhat larger bill per unit volume; the charge for gas being the same per volume, and the increase due to the fixed charges being divided by a smaller number of units. The consumer of from a few hundred feet down to "no gas" a month, would pay the cost of keeping up his meter and service pipe and collecting his bill, the items that now make his patronage unprofitable to the company supplying him, and any gas he used would then yield the same profit per unit of volume as the gas used by larger consumers. Thus would the man who insists on having a meter to insure against the failure of other sources of light, or to illuminate his house on festive occasions, become a source of profit to the advancement of justice and the interests of the company and its patrons. The consumer of more than the average volume of gas, under average meter and service pipe cost conditions, would get his gas at a cost less per unit volume than that of smaller consumers, by the amount that it cost less to supply him. Large consumers who are now enjoying rates lower than the average by a sum in excess of the difference in cost of supplying them, would find the price higher to them than under present conditions. Inasmuch as concessions in price to large consumers are generally asserted to be based on the justice of giving them the advantage of this difference, advocates of such concessions must hail the plan under discussion as contemplating a complete and systematic enforcement of their principles.

It must be noted that these disproportionate concessions to large consumers are claimed, with some show of reason, to be not to the disadvantage of the smaller consumer, because the measure of profit obtained on the gas sold them goes toward the payment of the dividend on the investment already made, and this, it is asserted, reduces the amount of profit to be obtained from other sales. Two answers to this argument are obvious. It cannot be certainly predicted of consumers of this class that, unless they obtain unreasonable concessions, they will not burn gas; and, inasmuch as the investment must ultimately be increased in proportion to the demand for gas, the accession of this class will not affect the interest account. Hence, to obtain them at largely reduced rates may have an effect on the price to the smaller consumers the reverse of beneficial. The supporters of this argument in favor of special prices to large consumers are misled by the generally existing margin of capacity in a plant, into the feeling that no new investment is necessary to supply the new customer. Each new customer narrows the margin, and advances the day when more investment must be made, and should therefore be regarded as requiring an investment in plant, exactly proportioned to the amount of his consumption.

The effect of the adoption of the principle in question on the gas company—What? The conditions under which gas companies do business in their relation to the principle under discussion, vary, and certainly the immediate effect of the enforcement of this principle would be as various. Custom breeds a sense of obligation, and doubtless many consumers at lower than regular rates have come to accept the reduction as a vested right, and would threaten, and probably at first, make trouble, if their price were raised. The abrupt adoption of this principle by a company already established in business could be accomplished with the minimum of friction only at the time of making a reduction in the price of gas; small consumers being then put on the same footing as large, in the price per unit volume, the price to the large consumer not being raised, and the meter rent charges giving him all the advantage in total cost that he is entitled to. Doubtless many large consumers

would claim that a lower price than this arrangement would give should be granted them, and threaten us with electricity; but in the light of our present knowledge of the cost of incandescent electric light, does it not seem that we are making undue concessions to large consumers from fear of it? Every concession so made postpones the day when we may again advance upon the other and more formidable enemy to the extension of our business. Kerosene is the competitor that can block us out of one portion of the trade we seek, and always to its own profit. When the incandescent electric lamp displaces us by reason of a lower price, it is seldom to its profit, and such a warfare cannot long be maintained. Therefore, it appears that in the long run the large consumers who now make us afraid with their threats and acts of wiring their buildings if they do not get a reduced rate, will again work the meters that they at all times refuse to have disconnected. In seeking indications of the ultimate effect of a new departure, the effect, after the influences of the old system had passed away, no method is safer, nor more simple, than to study the probable course of an enterprise started on the new lines, unembarrassed by precedent. Where would a gas company stand to-day, financially, and in the graces of its customers, if it had adopted at and adhered to from the beginning of its existence, this principle of placing all consumers upon the same plane? The justice of such a course must commend itself to all men. The fact of meter rent charges being an old story, and the reason and effect of them understood, would probably prevent any general objection to them.

Equitable treatment is a long step toward popularity. The prevalent idea of a meter rent has been that it respresents what the Creoles call a "lagniappe"—something demanded in addition to the regular and legitimate payment for service. Once understood as a fixed charge made to put all consumers upon the same footing, and that it is not an addition to the cost of gas, objections to it would be few, except on the part of people who, from the smallness of their consumption, are now a burden on the company and its other customers. Hence it would appear (always supposing my reasoning to have been good) that the adoption of the principle of meter rents and uniform prices per 1,000 cubic feet would not result in a smaller measure of popular approval than gas companies now enjoy.

The active competitors of gas for the business it would call its own are kerosene and the incandescent electric lamp; the former in residences and stores, the latter in stores, factories, etc. The only desirable class who would be prejudicially affected by an abrupt change from the old system of charging to that under discussion, the consumers who now get special rates, make their choice between the incandescent electric lamp and gas. If the former is cheaper to them it is unprofitable to the company supplying them, and this competitor need not be greatly feared where the issue is made on the mere dollar and cent grounds. The objection that isolated electric plants will be put in by large consumers, if they are not given special gas rates, is answered by the fact that this is done to the greatest extent where gas is cheapest, light for light, in the large cities. Where the incandescent electric lamp is used to-day, and still more, where it will be used five years from to-day, unless some means of cheapening it can be found, the deciding argument between it and gas is not, nor will be, the financial. But if it were, the greatest inroads upon our business made by this competitor at this date appear to be among the class of customers (stores, saloons, etc.) who buy from us more gas than the average, and less than the special rate customers; the class that would be most benefited by the adoption of the "meter rent" system in the meaning of my title.

These considerations lead me to believe that the adoption of the equitable plan of selling gas to consumers of large and small quantities at prices that shall result in the same profit per 1,000 cubic feet to the company supplying it, would not prove injurious to the company's interest.

[The last paragraph of Mr. Clark's paper contains a reference to an editorial, published in a New York contemporary, in the spring of 1890, which, Mr. Clark submits, is worth the study of those interested in the question.—EDS.]

Discussion.

The President—You have heard a very carefully prepared and terse statement, by Mr. Walton Clark, upon this very important question, and I trust the members will give it ample and free discussion. It is as old a friend of ours as "leakage," and nearly as dear to our hearts as "naphthaline." As the question of meter rents is a burning one to many of us, I hope many of you are prepared to discuss it; and I know that Mr. Clark is ready to answer any questions.

Mr. A. G. Glasgow—The Chairman is correct in the statement that the question of meter rents is an old one. I do not think, however, that that view of the case exactly expresses the idea conveyed by Mr. Clark's paper. As I understand it, what Mr. Clark proposes is a solution by means of meter rents of the vexed question, "What reduction is it right to allow to the large consumer of gas from the standard price to the average or small consumer?" I followed Mr. Clark's reading of the paper as closely as possible, but I find it hard to criticise this question favorably without rehearsing to a very considerable extent what Mr. Clark has already stated; and to me it is equally difficult to discuss or criticise the paper unfavorably, because I can find nothing unfavorable to say about the proposition. The keynote to it seems to me to lie in the question, "Is is fair, just or lawful" (I perhaps almost quote Mr. Clark's words in this respect) "to charge one consumer of gas a greater interest on the investment necessary to serve him than we should charge another consumer on the investment necessary in his behalf; each one, by Mr. Clark's system, paying his exact proportion of the general expense of distribution?" I doubt if there be a person here who would have answered this question affirmatively, whose opinion has not been severely shaken by hearing this paper; and I am pretty well satisfied that the careful reading of it will entirely revolutionize his opinion. Following up the judicial discussion quoted by Mr. Clark, what are our relations to the public? People aggregate to form cities; they combine for their mutual convenience; they construct lines for rapid transit, or they give franchises to others to construct and operate them in their behalf; they form police systems; they have the streets paved; they establish fire departments and build water works. They require light. In many cases they serve themselves, and in other cases they employ corporations to furnish light for them, authorizing them to use the thoroughfares, that are owned in common by all. It would seem to me as just to charge different citizens such prices as will give us varying profits per thousand, or per unit of our product—as just to do that as it would be for the city to levy upon the people varying rates of taxes in support of the above-named institutions. We supply light for the same purpose for which they pay taxes—for the general convenience of the citizens. I feel that I have not in this connection said anything that strengthens Mr. Clark's position, but I did not expect to do that. I simply wished to put myself on record as indorsing his position in this regard. Of course, it goes without saying that if a body of gas men are convinced that a certain step is morally right, nothing else will enter into their computation. Looking at it, however, as a matter of policy, as some of our friends in the electric light business, and in the water business, or something of that sort, might do, it seems to me that on this ground also Mr. Clark is entirely right; and that it is for the benefit of the gas company not to sell their product to a man, because he is a large consumer, at a rate which does not give them the stipulated return per thousand. We sell to the average consumer at a price which gives us a far return on our product. Where is the point in selling to anyone at a price which does not give us such a return? The thought that first occurs to many of us in this connection is that we have a plant capable of putting out a certain amount of gas, and it is working only to, say, two-thirds of its capacity, while those who are burning that two-thirds capacity are already paying enough money to make the usual rate of interest on the whole investment; and it seems to be reasonable at first thought that we can afford to fill up the plant at a lower rate per thousand. As we are already getting interest on the investment, why cannot we supply the other one-third simply at cost? Or, suppose we say that we will make a little on the other one-third; that we will sell the other third at a reduced profit which, added to our present earnings, will make us that much better off. Apart from the injustice of making two-thirds of our customers help bear the burden of the other third, what is the immediate effect of such an arrangement? We fill up our plant; another consumer applies; then, according to this reasoning, that one man must be charged with all the money that is necessary to invest in a new works or the enlargement of the present works. That is the necessary result of this line of reasoning when carried to its limit. If you fill up your remaining one-third at a less rate than is necessary to pay its fair proportion of interest on the invested capital, then, your margin of capacity being exhausted, this one man, the last straw that breaks the camel's back, must contract with you to pay for the new gas works, or you cannot afford to let him in. The more I have looked into the matter (I do not pretend to have looked very far, but I have looked as far as I can see) of supplying small consumers, the more I am satisfied that every gas company has a large number of small consumers to whom they are monthly handing out so much money for the pleasure of allowing them to keep a meter and burn occasionally a small amount of gas. A great many works have adopted the plan of sending out a bill for a certain amount whether they burn it or not. That is one way of getting around it, but it is an arbitrary way. This plan under discussion seems to me to be practicable, and, as it is based upon figures, it is certainly just. By its adoption the gas company will receive per 1,000 feet

of gas consumed the same amount of profit from the consumer, whether he be a big or a little consumer. If he be a big consumer he is delivered the gas cheaply, and to that extent he gets the benefit of it. He gets the benefit of what we are able to save. Outside of that I do not see but what the small consumer has to suffer for whatever concession we give him. The small consumer is a very valuable man—if he is not too small; and Mr. Clark's system protects us against the man who is ordinarily too small by a method that enables us to make money on him.

Mr. E. H. Jenkins—I understand Mr. Clark takes the position that gas companies and railroads, as public servants, should work upon nearly the same principle. We who come from very small towns, and get into New York city only occasionally, and have occasion to use the "L" road and the horse-cars, find that on the "L" road you can ride ten blocks and pay a nickel, or you can ride 120 blocks and pay just a nickel. Would it be policy for that road to undertake to charge different prices for the different services rendered?

Mr. Walton Clark—I would like to say in answer to that suggestion that if the same rule were applied to the "L" road that is applied to the longer roads they would be compelled, as far as they practically could, to make that distinction; but there is so little difference of cost in the general business of the "L" road, between carrying a passenger ten squares and carrying him 120 squares, that it is not worth considering. It is not worth the trouble or expense of keeping track of where a man travels to on the "L" road. If they attempted to do that it would in the end cost the traveler more who only traveled ten blocks than it costs him now to travel 120 blocks—if they put on the laborers, ticket men and gate men whom it would be necessary to have to keep track of where a man is going. Otherwise it would be done, because there is no uncertain language in the decisions relating to railroad management; and the Interstate Commerce Law or the discussion preliminary to it covers that point perfectly.

Mr. E. H. Jenkins—I recognize very clearly the fact stated by Mr. Clark, that it is not practicable to make that distinction; but would not the difference between supplying one customer and supplying his next door neighbor, be so very small that it would be impracticable for us to carry out your plan? Don't you think they would get mixed pretty nearly as badly as the "L" road passengers would be?

Mr. Walton Clark—If the customers, side by side or ten miles apart, had meters of the same size, and services of the same length, and used the same amount of gas, it would cost exactly the same to supply them; but if one consumer is a church, and uses 3,000 feet of gas per month, and has a 100-light meter through which to measure it, and a corresponding service, while the consumer next door is a householder, and uses 3,000 feet of gas per month through a three-light meter, and has the service necessary to supply him that amount, then to supply gas to the church costs several, say, about ten cents per thousand more than it is costing to supply the consumer through the small meter. There is a very decided difference, and it is a difference that is easily gotten at. There is no difficulty about it. It does not add to the clerical force of the office at all. A table giving the cost of placing and maintaining different sizes of services and meters is all that is necessary; the charges are worked out from that, and the thing is done. If you will give a little thought to it you will see that that is very simply done.

Mr. E. H. Jenkins—I acknowledge I have not given much thought to it. The paper is new to me, but those questions flashed on my mind very quickly. I think in the case you speak of, as between the householder and the church, there would be quite a little difference, and that 10 cents per 1,000 would be a pretty high figure. But between the consumer with a 5-light meter, and who uses 5,000 feet per month, and the consumer with the same size of meter, who uses 7,000 feet per month, I think there would be very little difference.

Mr. T. Littlehales—If I understand Mr. Clark's position, the conclusion he arrived at is that the only equitable method is to charge meter rents. Is that the point?

Mr. Walton Clark—To charge a something, which I have called "meter rents," and which covers interest on the cost of meter and service in use at the place, the cost of repairing that meter and service, interest on the cost of repairs, and the cost of collecting the bill—all of which is so readily determined that, sitting at my desk, I worked the whole thing up for two different sized meters in 60 minutes.

Mr. T. Littlehales—So your conclusion is that charging meter rents is the more equitable system. With that conclusion I entirely agree.

Mr. Walton Clark—Charging a meter rent covering all those points. It is really more than a meter rent.

On motion of Mr. Jenkins the thanks of the Association were voted to Mr. Clark for his paper.

The President then introduced Dr. A. W. Wilkinson, of New York city, who read the following paper on

LIME.

Mr. President, Gentlemen of the American Gas Light Association: I do not think your committee fully appreciate the difficulties that one would be subjected to in writing a paper to be read before your meeting.

I see before me men who have spent years in the manufacture of gas, and are perfectly familiar with everything connected with it; men who have read every book published upon the subject; men whose written articles are to-day the law in every country on the subject of gas making.

A paper should be not only interesting but instructive, and, if possible, contain something new. How can I instruct you gentlemen; what is there new to present? Nothing. I am forced to take up a subject that has been written on many times, and I do it in its defence. I refer to lime. Lime is so universally distributed in this world that, turn whichever way we may, we are sure to see it. Take up a handful of earth, what is it? A mass of oxidized metals, and lime is sure to be one of them; go deeper, examine the rocks, lime is sure to form a part. We can hardly find a stone or rock that does not contain lime.

If we analyze the waters of the earth we will surely find this all-important substance, lime; even the air contains lime.

Leaving this earth, and by the aid of the spectroscope examine the light given by the sun and the fixed stars, we see the beautiful red, yellow and green bands which tell us that lime is burning there.

To Sir Humphry Davy we are indebted for demonstrating that all earths have for a base a metal. In 1808 he isolated calcium from a lime compound—28 pounds of caustic lime contains 20 pounds of this metal. Of the 54 metals known on this earth, most are white or nearly so; the others have the color of gold (with which you as gas engineers are so familiar). Unlike gold, calcium is very oxidizable.

I have here a sample of calcium; it has to be kept in naphtha, a substance free of oxygen, to prevent it turning to the oxide of calcium, or caustic lime.

I do not propose to speak of the thousand and one salts of lime, although they form an interesting and useful class of bodies, or of the many rocks that lime forms a part, but will confine myself to the great group of carbonates.

We find the carbonate of lime precipitated from the waters of the earth and often mixed with other earths known as lime rock; in the latter rock formation again, as marble, which at one time was some form of shell life, having been subjected to both heat and pressure. Occasionally, instead of the pure white marble, we find it black, or yellow, or green, or flesh color, in fact, every shade of the rainbow, depending upon a slight amount of coloring matter, but in all cases being almost pure carbonate of lime. Again, the shells that we see upon the seashore, or the coral that forms so much of our earth in the equatorial regions, are carbonate of lime; the beautiful pearl that we admire so much, and at one time when dissolved in vinegar formed an expensive and fashionable drink, is carbonate of lime—I doubt if a cocktail made of pearls would meet with ready sale at the present time, although, as a medical preparation, it might be very useful.

I have here a crystal of carbonate of lime, Iceland spar, which possesses the wonderful power of polarizing the ray of light; that is, enabling one to see double without the aid of diffusible stimuli. May it not be possible that some engineers have glasses made of this substance when they report the amount of gas made from a pound of coal? Gas consumers swear that the clerks who make out their bills, wear glasses made of this substance continually. Heat the crystal, drive off a little water and carbonic acid, and you have left, caustic lime. When any of the forms of carbonate of lime are subjected to heat in a draft of air, or better still, both air and steam, the carbonic acid is driven off and we have left, caustic lime. This substance has a great affinity for water and will combine with it so actively that a great amount of latent heat is set free—the compound formed is the hydrate of lime, the substance that you gas engineers are so familiar with, and spoken of as lime.

The burning of lime is carried on for so many purposes that it scarcely needs more than a passing notice; yet to do it properly we require something more than the heaping together of a quantity of lime rock and fuel, setting the fuel on fire and allowing it to burn for a number of hours. Many patents have been taken out for lime kilns, claiming great economy in fuel and producing pure caustic lime, the secret of success being a free draft of air aided by a little steam. It was the custom at one time for gas companies to do their own lime burning, and I am sure to day that it would be one of the best paying and most useful department of the works.

Soon after the discovery of gas making by Murdock, lime was suggested as the best substance for its purification, or to free it from its bad smell.

It was well known that whitewash in some way purified the air of the room in which it was used, but the chemistry was unknown. The fact that lime would thus act led to its use as a purifier of gas, first, in a liquid form, or cream of lime. Some possibly remember seeing in our old works boxes arranged for passing the gas through the lime. In this shape it did its work very effectually, in fact too well; for often much of the illuminants would be washed out. The fact that the lime becomes very offensive in removal led to its discontinuance, and the substituting of lime in a comparatively dry state, such as we are familiar with in all of our works to-day.

Many substitutes for lime have been offered for purifying gas and they have all failed to meet all of the requirements in effective work, or come within the limit of cost. The only one that has at all become popular is the hydrated oxide of iron, and this only in part fulfills its mission. Lime will filter the gas, absorb the sulphureted hydrogen and carbonic acid. With iron we can only do the first two, allowing the carbonic acid to go free, to the great injury of the quality of the gas, causing it to burn with a reddish light, with tendency to smoke, for carbonic acid is a regular dog in the manger; it will not burn itself or let the other combustible gases burn. Many engineers who use iron for purification make up the loss of light by a little more of the enricher, be it either cannel coal or oil; but this method is never quite satisfactory, the oxide's recommendation being its cheapness and the enormous amount of gas it will purify. The place for the iron is before the lime; that is, pass the gas first through the iron box, then through the lime.

At the present time there is a great competition in light, and it obliges the engineer to not only give a volume of light, but it must be of a fine quality, and lime, the good, old and faithful servant that has been with us since the beginning, can do more to secure that than any one thing; help it if you choose with iron, but do not try to do without the lime.

It has been often asked, how much gas ought a bushel of lime to purify? Twenty eight pounds of pure caustic lime, when properly slaked, that is, converted into a hydrate, will combine with 22 pounds of carbonic acid, or 188 feet. The same weight of lime will combine with 17 pounds of sulphureted hydrogen, or 188 feet, but these figures are of no practical use, for the reason we never have pure lime rock, or shells, or marble, and often it is imperfectly burned, or is imperfectly slaked, or it has been exposed to the air and already absorbed carbonic acid, and possibly sulphureted hydrogen—the boxes may not be of the best form, or the lime properly put in, and then again, we have the gas with a greater or less percentage of impurities. So you see, to give the exact amount that a bushel of lime will purify, you require to know all of these facts.

Some engineers think that lime should purify the same amount of gas, no matter what the condition of the gas is. For instance, coal will be purchased that contains 5 per cent of sulphur, which, when subjected to distillation, is sure to give sulphureted hydrogen, bi-sulphide of carbon, sulphide of ammonium, in large quantities. Again, the coal will be used wet, or often covered with snow and ice; such coals will make large quantities of carbonic acid, and the amount of lime for purification will be proportionately increased.

With your permission I will suggest what would be an ideal plant for coal gas making, that would give the lime the best chance for effective work:

1st. A bench so well set that the retorts shall be uniformly heated, whether by an ordinary or a regenerative fire, to a high heat.

2d. That the coal should be a good caking coal, free as possible from sulphur, and dry; that is, it should be kept well housed, for coal exposed to the elements rapidly deteriorates.

3d. As high heats should be carried as can be carried without producing pitch in the hydraulic main.

4th. The exhauster should be run so as to keep as near zero in retorts as possible—to produce a vacuum in the retorts you run the risk of drawing in furnace gases, and a pressure means less yield.

5th. The condenser should be ample so as to cool the gas gradually. In a small condenser the gas rushes through so rapidly that much tarry vapor or oily compounds escape condensation, going over to foul the pipes and other apparatus and coat the lime, preventing it from absorbing or combining with the carbonic acid or sulphureted hydrogen.

6th. Condensers are almost always too small. Perhaps they were large enough when first constructed, but the growth of business soon overworked them and no provision is made for extension.

7th. Next, the scrubbers—here a most important part of the purification takes place. Experience has taught that to wash with pure water is an injury to the illuminating power; to pump the water over and over again until it is saturated with the chemical compounds, is less expensive and produces better results. One cubic foot of water will dissolve 480 cubic feet of ammonia, the carbonate of ammonia which is formed by bringing the ammonia and carbonic acid together is also dissolved as well as the sulphide of ammonium, all of which is very desirable to remove from the gas.

8th. We now have the gas in such a shape that the iron, the use of which I should most surely advocate, will combine with the sulphureted hydrogen freely, one box being sufficient to do the work for many thousand feet daily. Finishing with the lime, which having only the carbonic acid to take care of, will do enormous work, surprising many who have been in the habit of neglecting the points I have mentioned before.

Coal gas made and purified in this way, is as pure and white as can be desired; but it is limited in its candle power—16 to 18 is as much as you ought to expect. It is better for heating and cooking, or power, containing as it does, more heat units than any other gas. If you want more candle power (instead of loading it up with naphtha vapor which will give you the increased candle power and at the same time change the quality of the light, making it reddish, and with great tendency to smoke) go directly to water gas. Here it is easy to get a 30 candle gas pure and white; if this is too high, a mixture of the two in equal parts is most satisfactory.

As I have followed the making of coal gas from the retort to its final purification, it may be well to do the same with water gas as you will see it made in New York.

The first step in the operation is to produce the non-illuminating water gas; that is, the gases made by the decomposition of steam by red hot carbon. For this purpose we require a cupola; that is, an iron vessel of from 6 to 8 feet in diameter, 12 to 15 feet high lined with fire brick. Into this we place coal and set it on fire, with a suitable blast. We bring the coal to a full white heat, then shut off the air and close the outlet of the products of combustion, open the valves leading to the hydraulic main; now turn on steam, which will be rapidly decomposed into carbonic oxide and hydrogen. These gases are forced into a holder, from the holder they pass to the illuminator, a vessel so arranged that the gases become thoroughly mixed with the vapor of naphtha in such quantities as will produce the candle power desired. From the illuminator the gases and vapor of naphtha pass to the through retort heated with oil or coal; it enters at one end and is converted in its passage through to a perfect gas. That is, the naphtha will, in the presence of water gas, be entirely decomposed into illuminating gas, without waste oil or lamp black. The exhauster sends it through the condensers and the same care should be observed as in coal gas condensing. You do not really need a scrubber, for we have no ammonia, very little sulphureted hydrogen to dissolve (a dry scrubber that will cause friction of the gas is well, but not a necessity). It is now ready for the iron and lime boxes. Four and one-half (4½) gallons of naphtha will give a 30 candle gas.

At the Mutual works, this city, we have for years been reburning the spent lime. It is first pounded into bricks and then burned into caustic lime in kilns, the same as is used for burning brick. The cost for a bushel of slaked lime is from 3 to 4 cents.

There seems to be no limit to the number of times the lime can be reburned. It will purify just as much gas as when first burned. This places lime in the hands of engineers at a price that enables them to use it constantly, and make a gas that will not only compete with electricity, but will be vastly superior in brilliancy and cheapness.

Whenever you hear that electricity is making rapid strides in a place, you may be sure that the gas is poor or badly purified. We have a grand future for gas of high grade. The day for poor gas has passed, and the engineer who is content to make a gas that will burn, no matter how, red, yellow or smoky, will find his occupation gone. There is no excuse for poor gas at the present time. Material of the best is at hand. The science of gas making is well known. The public demands good and pure gas, and that can only be produced by the proper purification with lime.

Discussion.

The President—In writing this paper, Dr. Wilkinson has added one more chapter to the large amount of instruction that he has given the gas fraternity. The Doctor will answer any questions that any of you may wish to propound with regard to the lime process.

Mr. A. S. Miller—The Doctor made one statement which I do not think anybody will dispute—in speaking of the milk of lime absorbing the illuminants of gas. Now, if the milk of lime will absorb the illuminants, will not dry lime do it? A test was made by Connelly &

Co., about three years ago, of oxide against lime. The apparatus was very carefully arranged, and I think the gas contained about 2 per cent. of carbonic acid. That is my recollection from reading the article some time ago, and I am not sure that I am exactly right. However, this gas contained at least 2 per cent. of carbonic acid. The tests, after being very carefully made, show that the lime absorbs sufficient illuminants from the gas to keep it down to about the same candle power as gas purified with oxide, but still containing the carbonic acid. I would like to say that in making gas now we are using practically only oxide to purify with—all the other conditions being the same as they were a year ago when we used lime entirely—and we are getting just the same results in illuminating power per gallon of oil used as we were a year ago. I think that the lime absorbs sufficient illuminants from the gas to keep the candle power down to the point that oxide will keep it, on account of not absorbing the carbonic acid.

Dr. A. W. Wilkinson—In answer to that I would say the hydrate of lime has no effect upon the illuminating gases. Water will absorb 6 per cent. of illuminating gas—that is, 1 cubic foot of water will absorb 6 cubic feet of illuminating gas. Now, if you add your lime wet, it is not the lime that absorbs the illuminants; it is the water. If you have your lime dry (that is, a hydrate, for that is the sort of lime you have used) it will have no affinity for the illuminating gases; it can only combine with sulphureted hydrogen and carbonic acid. There is no affinity for the illuminating gases, and it cannot combine. The only possible deterioration that could take place would be as to what it could mechanically hold, but there would be no combination.

Mr. Walton Clark—Lime as commonly prepared for the purifiers is not a simple hydrate; it certainly carries a large amount of water with it. I have been brought up to believe, and experience has borne me out in the belief, that the more water you could make your lime carry, and still leave it porous, the better would be the purifying effect, while at the same time a greater amount of hydrocarbon would be absorbed. So far from the hydrate of lime having little or no effect on the illuminants of coal gas, it appears from experiments to have very considerable effect. Mr. Blodgett described before this Association, at the last New York meeting, some very satisfactory experiments in that line, and I think he demonstrated completely that there was a greater loss of illuminating power from the use of lime than from the use of oxide. Perhaps I should not say "loss of illuminating power," but that there was greater illuminating power in the same gas, or different portions of the same gas, passed through oxide than in that passed through lime. There is a gentleman here who told me (but as he did not say it before the Association I will not use his name) that he had thrown lime into the retort and made good illuminating gas with it after it had been used in the purifiers. In my own experience I have found that the oxide purified gas had as high illuminating power as lime purified gas, and that while the oxide leaves in carbonic acid, it also leaves in something else which the water in the lime takes out.

Mr. S. F. Hayward—I would like to ask Dr. Wilkinson what they use at the Mutual works with which he is connected?

Dr. A.W. Wilkinson—We first purify the water gas as it comes from the cupolas, and then it is passed through to the holder. After the oil has been added it passes through the boxes—the lower layer containing ashes, and the upper layer containing oxide of iron. Now, as regards the water that we have in excess over the hydrate in lime, I may say any excess of water of that kind is unnecessary, and should not be used. If you have ever used oxide of iron you will know that it always contains more or less water—possibly as much water as the excess of water in the hydrate of lime.

Mr. T. Littlehales—In the majority of works, where there are only four purifiers, and where they are using lime exclusively, I suppose the lime would come out in the shape of sulphide, or "blue billy." In that case, in burning the lime, would there not be a nuisance created by its reburning, in giving off sulphur in the form of sulphureted hydrogen? Have you experienced any difficulty in that direction?

Dr. A. W. Wilkinson—Not at all. I would say that the sulphur as soon as it is subjected to heat undergoes oxidation, and burns, not into sulphureted hydrogen, but into sulphurous acid, and passes off.

Mr. T. Littlehales—That is still worse.

Dr. A. W. Wilkinson—No; because you never burn a ton of coal that you do not produce sulphurous acid. It is simply the small amount of sulphur turned into sulphurous acid. With us the amount of sulphur in the gas is very small; it is nothing like what it would be in coal gas making where a large percentage of sulphur exists in the coal. Hence we experience no difficulty whatever. Neither does the lime burn into sulphate of lime—plaster of Paris. This is well proved by analysis. After three or four hundred times reburning the lime we find that it purifies just the same number of feet per bushel as it did when first put in.

Mr. W. R. Addicks—As I understand it, the more water there is in the lime the more illuminants would be taken out of the gases. If that is so, then the wet purification process (the milk of lime process) is better adapted for coal gas than for water gas. Does not that follow?

Dr. A. W. Wilkinson—I do not see that. You are limited to the amount of illuminants in your coal gas. We will suppose that it is 6 per cent. by absorption. Now, you pass it through cream of lime and you can reduce that to 3 per cent.; consequently, you reduce the illuminants in that same proportion.

Mr. T. Littlehales—I think Dr. Wilkinson has overlooked one important fact with reference to the existence of water in the lime. I think every member of this Association remembers the light thrown on the purification question by the late Mr. Forstall, who showed us the enormous advantage to be gained by having the lime thoroughly wet. Now we must not forget that water, as ordinarily used, is itself a purifying agent, absorbing, as I have always understood, 700 times its bulk of ammonia gas, instead of 480, as you put it; that the water absorbs a large percentage of ammonia, and that the ammonia in turn neutralizes a considerable amount of sulphureted hydrogen. And so water that is held in mechanical combination with lime becomes a purifying agent. I still hold to the principle of having the lime pretty thoroughly wet, and I think that it is a more efficient purifying agent in that condition—due to the excess of water there is in it. Of course, if you have an ample wet surface in your scrubbers or washers, then it is not necessary.

Mr. F. Bredel—As far as the purification by lime is concerned, lime has, under no condition, an affinity for absorbing any illuminants whatever, provided such illuminants are in the form of gas, and not as vapors. But if they are vapors, naturally they make the lime easier of absorption, and the benzole vapors, or whatever vapor it may be, will be decomposed. If you keep the lime thoroughly dry they will not be deposited so easily. I think that explains why in the wet lime purifying process you absorb the illuminants. I think these illuminants would be lost somewhere in the holder, or somewhere in the pipes, so that there is practically no absolute loss from purification.

Mr. G. B. Neal—I understood Dr. Wilkinson to state there was a loss of 6 per cent. of the illuminating power of the gas by absorption, where water was used, and that it was not necessary to use water in the scrubbers in either water gas or in coal gas. Then I made up my mind that when I got home I would order the superintendent to shut off the water. That might do very well with water gas, but it occurred to me that there was a good deal of ammonia in the coal gas. Suppose we discontinue the use of water with coal gas, what shall we do with the ammonia? How shall we eliminate that?

Dr. A. W. Wilkinson—You misunderstood me. I should have said that in the scrubber we do not use pure water, but do use water that has been partially saturated with ammoniacal salts. As every gas engineer fully knows, it is far better, for the illuminating power, to wash the gas with ammoniacal liquors than to wash it with water. You will understand what I am driving at. I want to make the coal gas pure and white; I want to make it so that it will compete with electricity. I do not want that coal gas loaded with vapors of naphtha, or with carbon gases; for that will make it reddish or yellowish, or so that it will have a tendency to smoke. Hence we make every effort to relieve the gas of every impurity, leaving the gas as it comes from the coal—good coal—well purified and of a beautiful white color. If you leave the carbonic acid in you have a reddish gas, with a tendency to smoke; if you load it with naphtha vapor you have a reddish glow. You increase the candle power, but the quality is deteriorated.

Mr. G. B. Neal—On one point you say you want to make coal gas to compete successfully with electricity. As many of my friends are engaged in the manufacture of both kinds of light, we can offset one another.

Mr. C. F. Prichard—Some years ago I was investigating the point whether lime absorbed any illuminants. We measured a sample of gas, filled a small holder with it, and made several complete analyses of it, with particular reference to the quality of illuminants contained. We then passed a portion of this gas through lime. The result, in amount of illuminants, was substantially the same as it was before it passed through lime. We then repeated the same operation through iron sponge, and obtained substantially the same result—12 or 15 tests which we made showed there was no appreciable reduction in the amount of illuminants, either by passing through lime or through oxide of iron.

Mr. A. G. Glasgow—I have listened with pleasure and interest to Dr. Wilkinson's remarks about the reburning of lime, and I would like to

ask him if he can recommend the reburning of lime as being commercially successful where the cost of disposing of the spent product is practically nil. I ask that question because I have recently looked over a very large plant where they burned the spent lime, and was told that it was not worked with commercial success.

Dr. A. W. Wilkinson—I think we have now, for about six years, reburned our lime. The lime was originally shell lime. It had been used in the boxes until it ceased to be of value. We placed that lime in kilns, and subjected it to heat for about 16 hours. At the end of that time we found the lime had been converted into caustic lime. Then we placed it in slaking boxes, and it slaked into hydrate of lime. We find that it will do just as much work on the one-hundredth burning as it did at the beginning. The lime seems to be like sponge; if you put one in water it becomes full of water, and if you remove it and squeeze it the water will go out, after which it will take up just as much water again. The expense of reburning that lime has been, including every detail, from 3 to 4 cents per bushel. In the summer months it would be 4 cents per bushel, for that is when we have to repair the kilns. Now, gentlemen, think for a moment what is that lime. It is the carbonate of lime. What do we do with it? We place it in the kiln, burn it, and thus drive off the carbonic acid. Slake it, and we have the hydrate of lime. Now, what have I coming from the lime boxes? Nine-tenths of it is carbonate of lime. Then I pound it into a brick, or into some other shape. When it is subjected to heat it undergoes the same process that lime does. I am doing nothing different from what was done originally.

Mr. A. E. Boardman—It seems to me that Mr. Glasgow's question resolves itself into the first cost of lime. If it cost more than 4 cents per bushel, then the Doctor's process is a saving; if it cost less, it is not.

Mr. F. C. Sherman—I would like to ask Mr. Slater for his experience in the use of lime burned over. He tried it years ago, and I would like to have him tell us what he did with it.

Mr. A. B. Slater—We did have an experience with reburning lime—we used what is known as the Hislop apparatus, and found we could not reburn the lime with that apparatus to advantage. In other words, if our lime cost us 11 cents per bushel we could not burn it to advantage. We tried it for about a year. We found that where the lime contained carbonic acid we could reburn it several times, but that where it contained sulphur we could not reburn it to advantage more than two or three times, and we gave up the process of reburning it.

Dr. A. W. Wilkinson—Was the lime in a loose, powdered state?

Mr. A. B. Slater—It was.

Dr. A. W. Wilkinson—The secret of reburning lime successfully is that there shall be a free draft of air. It is better to have a draft of air and steam. Now, with loose lime you cannot do that. If it is pounded into a brick or is in lumps, so that there can be a free draft of air, aided by a little steam, the sulphur and carbonic acid both, will be driven out.

Mr. J. F. Scriver—Mr. Baxter, of Halifax, has had some experience in reburning lime, and I will ask him to state it.

Mr. R. Baxter—The conditions in Halifax are somewhat different from the general run of towns both here and in Canada. The lime costs us about 45 cents per bushel and spent lime would be useless. We adopted the Hislop process two or three years ago, and it was successful with us. I do not know exactly what it costs us to reburn—at what rate per bushel—for we do not keep any account of that. We run a double set of apparatus in the daytime. One man can run the whole apparatus, and we never have more than one man in the 24 hours. He reburns, slakes, and prepares the lime for use. We lay off the kiln about two months in the summer time. The repairs so far have been very slight indeed. I think that two or three days' work is sufficient to put them into good shape. I suppose next year we will have to spend a little more; but, practically, the cost of wear and tear is very little. We use the Irish bog ore and lime. We use about 3 feet of oxide and 1 foot of lime in each box—the oxide at the bottom and the lime on top. The gas comes in at the top and descends through the box. We tried it with the lime in the bottom and the oxide on top, but it was then more troublesome to fill the purifier, more troublesome to keep the two substances apart. We did not notice any advantage in that process, so we abandoned it and went back to the original plan; namely, oxide in the bottom and the lime on top.

As everyone knows, there is a large quantity of sulphur in the coal which we use—a much larger proportion of sulphur than there is of carbonic acid. I do not think there is quite 1 per cent. of carbonic acid in our as when it enters the purifiers. We scrub it well. From the first scrubber we get a strong liquor; from the second a weaker liquor; and the third is the standard scrubber. Our Government Inspector's report gives us about 7 grains of sulphur in other forms, but not a trace of ammonia. It may be thought we are using a small proportion of lime as compared with the oxide; namely, about 1 part of lime to 3 parts of oxide. Our carbonic acid is practically all removed. The reburned lime that we are using now has been in use, a part of it at least, since we commenced, three years ago. We do not find a particle of difference in the quality of the lime in respect to its purifying qualities. Of course in any little building that is going on in the works we take what lime we want to use from our stock of lime, and find that it makes a good building mortar, that it is as hard as cement. We get our stock of lime in the winter time by burning oyster shells; and we also get Jamaica lime which the schooners bring as ballast to Halifax. We get that sometimes at a very low price. Taking everything into consideration, we find we can use lime with our regenerative system very economically indeed. As I said at the beginning of my remarks, our conditions are somewhat different from those of others, and it would hardly be practicable for us to use lime only once, for we could not get rid of the spent lime. We are very well satisfied with the system as we use it.

Mr. F. C. Sherman—I would like to ask Dr. Wilkinson how much more lime it would take to remove the carbonic acid alone, or does he use it in connection with sulphur purification?

Dr. A. W. Wilkinson—Let me understand you. Do you refer to lime instead of sulphur?

Mr. F. C. Sherman—Suppose you wanted to use lime for removing carbonic acid, would it increase the quantity of lime if you wish to remove the sulphur in connection with it? In other words, does it take more lime to remove carbonic acid than it does to remove the sulphur and carbonic acid together.

Dr. A. W. Wilkinson—The compounds of lime are definite. You cannot make lime combine differently. Twenty-eight pounds of caustic lime will combine with 22 pounds of carbonic acid. Now, it cannot take sulphur at the same time. You cannot load it with the two. If it takes the carbonic acid it cannot carry the sulphur. So that if you have a gas which is part sulphureted hydrogen and part carbonic acid, the lime cannot carry as much of the two as it can if you have only one. In other words, 28 pounds of caustic lime can carry 22 pounds of carbonic acid, while it cannot take more sulphureted hydrogen; so that you cannot purify as much gas that contains both sulphureted hydrogen and carbonic acid, as you can if it only contains carbonic acid.

Mr. F. C. Sherman—Can any one present tell me how many feet of gas can be run through a bushel of lime and remove the carbonic acid after the sulphur has been removed?

The President—I think that would be a very difficult question to answer, because the percentage of carbonic acid in the gas might vary.

Mr. F. C. Sherman—Suppose that it is 2½ per cent. My experiments were made with gas which contained 2½ per cent. of carbonic acid, and I found if I wanted to remove that I had to use as much lime to remove it as I did when it was in combination with sulphur. In other words, there was no very great saving if I had to remove the carbonic acid apart from the sulphur. I tried that experiment, and found I had to increase the layer of lime continually in order to remove the carbonic acid. It finally took as much lime to remove that as it did to remove the sulphur. I would like to know if my experience tallies with that of other members who have given the matter attention?

Mr. T. Littlehales—Surely, there was some discrepancy in the test made by Mr. Sherman, because I think it is pretty well established that lime, having a greater affinity for carbonic acid than for sulphur, will keep taking up for weeks, and possibly for months, carbonic acid, after it has got fouled with sulphur. Our own experience at Hamilton is rather to the upsetting of Mr. Sherman's idea. We change only about four lime purifiers per year. Last year we changed four oxide and four lime purifiers. It is true that our boxes are very large, and we have had to arrange for the lime first and the oxide second. I have not the slightest doubt that the experience of many members of the Association is in conformity with my own, and we find that we can practically drive every bit of the sulphureted hydrogen forward from the lime into the oxide. Last year it cost us $48 for lime sufficient to purify 30 million feet of gas. We could not have done this had we not been using oxide of iron. If we had taken the lime out when it was saturated with sulphureted hydrogen, I suppose it would have cost us ten times that amount. But as it was, $48 worth of lime was sufficient for 30 million feet of gas.

Mr. R. Baxter—I have said so much about the Hislop process that I want to mention one additional point in connection with the sulphur and carbonic acid question. Mr. Littlehales has said that the lime takes up water, allows the sulphur to go on, and retains the carbonic acid.

That is the reason we use oxide and lime. I believe that the Hislop process is not suitable for the use of lime altogether. Another point is this. After the lime has been removed from the box it is sometimes as black as coal, and in the course of a few hours it becomes perfectly odorless. Taking up a piece of it there is scarcely the trace of a smell, so that it is not the slightest nuisance. Of course it is not kept very long; but the odor completely leaves it.

On motion of Mr. Prichard the thanks of the Association was voted to Dr. Wilkinson for his paper.

The Association here adjourned to Thursday, October 22d, 1891, at 10 A. M.

SECOND DAY—OCTOBER 22—MORNING SESSION.

The Association met at 10 A. M., Acting-President White in the chair.

The President—The first business in order is the reading of papers. The next on the list is that by Prof. E. G. Love, of New York city.

Professor Love then read the following paper on

THE ILLUMINATING POWER OF MIXTURES OF COAL AND WATER GASES.

At the meeting of the Association at Baltimore, in 1889, the question was raised whether the illuminating power of mixtures of coal and water gases was higher than the average of the two gases tested separately.

In accepting the invitation of your Committee to prepare a paper for this meeting, it occurred to me that possibly a few remarks on this subject might be as acceptable as anything I could offer.

The question naturally divides itself into two parts—first, is the advantage which has been claimed for mixtures of the two gases sustained by experiment; and, second, if it is, what explanation can be offered for this increased luminosity?

My first thoughts on this subject naturally turned to a speculation as to what, from a theoretical standpoint, would be most likely to be the case; but, as might have been expected, the results were not satisfactory. This arises, mainly, from the fact that our knowledge at the present time is not sufficient to warrant us in attempting any prediction as to the luminosity of a gaseous mixture from its analysis; and yet I think this phase of the question, as well as certain collateral matters, are not wholly without interest, and I shall beg your indulgence in briefly reviewing some points which suggest themselves.

The determination of flame temperatures by experiment is attended with many difficulties, and our knowledge of this subject is very meager.

For purposes of comparison recourse is often had to a calculated flame temperature, based upon the composition of the gas and the products of its combustion. These calculations probably do not give us an approximation even to the temperature actually produced in a gas flame, for the reason that we have no knowledge of specific heats of gases at high temperature, as well as on account of the dissociation which must take place in the flame.

They give, however, a theoretical temperature which, although of a merely relative value, we may often use with advantage.

Accepting Davy's theory that the luminosity of a gas flame is due to the incandescent carbon particles, it follows that a high flame temperature which increases the incandescence of these particles will give greater luminosity to the flame. It is, therefore, often supposed that there exists in illuminating gases some direct relation between flame temperature and luminosity. There are other conditions, however, which render this relation very uncertain.

Dr. Frankland has found that ethylene, burned by itself, gives a light of 68.5 candles, and that a mixture of 75 per cent. of ethylene and 25 per cent. of oxygen has a luminosity of 74 candles. Here the oxygen gives a more intense combustion, the flame temperature is higher, and more light is obtained. With ethylene alone the calculated temperature is 4921.6°, while the mixture with oxygen reaches 7350.8°.

The same authority has found that of the three diluents, hydrogen, marsh gas, and carbonic oxide, the marsh gas is the most valuable medium for carrying the heavy hydrocarbons, and that hydrogen is next.

A mixture of 75 per cent. marsh gas and 25 per cent. ethylene gives about 26.5 candles, while if the marsh gas is increased to 92 per cent. the mixture still has a luminosity of 17.6 candles. All mixtures of marsh gas and ethylene, therefore, furnish light, a fact in marked distinction from similar mixtures with hydrogen and carbonic oxide.

A mixture of 75 per cent. hydrogen and 25 per cent. ethylene gives about 22 candles; but when the percentage of hydrogen is increased to 90 the mixture ceases to be luminous.

A gas composed of 75 per cent. carbonic oxide and 25 per cent. ethylene gives only about 8 candles: while the mixture containing 80 per cent. carbonic oxide and 20 per cent. ethylene gives no light whatever. In other words, 10 per cent. of the ethylene is lost when mixed with hydrogen; and 20 per cent. when mixed with carbonic oxide.

The flame temperatures of mixtures of 25 per cent. ethylene with 75 per cent. of marsh gas, hydrogen, and carbonic oxide, respectively, are 4557° for the marsh gas mixture, 4878° for the hydrogen mixture, and 5127° for the carbonic oxide mixture; or the one having the highest calculated temperature is the lowest in luminosity.

Carbonic oxide consumed alone is non-luminous, but it has a high flame temperature. This arises from the fact that while its calorific power is low, the quantity of air required for its combustion is also small, as well as the products of its combustion. The high temperature raises the carbon particles of an added hydrocarbon to a greater degree of incandescence, and consequently produces a whiter light, but at the same time burns a larger proportion of the carbon without the production of any light whatever. Hence the higher flame temperature with greatly reduced luminosity.

In the case of marsh gas its flame temperature is about the same as that of carbonic oxide; for while the air consumed and products of combustion are greater, they are counterbalanced by the much larger quantity of heat yielded. In its mixture with ethylene it has its own carbon as well as that of the ethylene to heat, a less proportion of the carbon is lost, but the flame temperature is lower and the carbon particles are not heated to the same degree of incandescence as in the case of carbonic oxide. The latter is therefore better able to carry an excess of heavy hydrocarbon than marsh gas is.

For the purpose of comparison I have taken the following analyses of coal and water gases, to which I have added a third representing a mixture of the two in equal volumes.

	Coal Gas.	Water Gas.	Mixture.
Hydrogen	39.78	29.16	34.47
Marsh gas	45.16	24.42	34.79
Carbonic oxide	7.04	28.33	17.685
Ethylene	4.34	12.46	8.40
Ethane		0.78	0.39
Benzol vapor	2.04	2.88	2.46
Carbonic acid	1.08		0.54
Oxygen	0.06	0.21	0.135
Nitrogen	0.50	1.76	1.13
Specific gravity calculated	0.4644	0.6551	0.5597
Calorific power, heat units	19233.6	13913.6	16114.4
Air required for combustion of 1 lb. of gas., lbs.	14.70	10.22	12.08
Products of combustion from 1 lb of gas, lbs.	4.37	3.32	3.75
Flame temperature	4555.8°F.	4760.5°F.	4657.3°F.

While any comparisons of these figures must be taken with some allowances it appears that the air required for the combustion of one pound of the mixture is less than the average of the two component gases; the products of combustion are also a little less than the average, both of which are favorable to the mixture. At the same time the calorific power of the mixture is less than the average, which is unfavorable; while the calculated flame temperature is practically the same as the average of the two gases.

From a study of the question from this stand point I have been unable to find any grounds for supposing that the luminosity of the gaseous mixture in question would be greater than the average of the two component gases.

I think I must admit that the experimental part of my case is a little weak; not from the nature of the results obtained, but rather from the number of tests which I have been able to make. This arises from the fact that it was necessary to take the coal gas at the works of the Consolidated Company, and transport it to the laboratory in cylinders under pressure. The only objection to this plan was the rather limited supply of coal gas at my disposal. The gas was transferred from the cylinder to a holder before use, and the mixture used consisted of equal volumes of coal and water gases. Extremely uniform results were hardly to be hoped for, inasmuch as the final result was based upon the tests of three different gases, with the possibly accumulated errors of each. In nearly all cases several tests were made of each gas, and the average taken.

In the first experiment the coal gas tested 16.61 candles, the water gas 28.73 candles, and the mixture 23.08 candles—a gain of 0.41 candle over the average.

In the second case the coal gas gave 17.33 candles, the water gas 29.04 candles, and the mixture 23.15 candles, a loss of 0.03 candle. In this experiment the coal gas may have contained a very small percentage of water gas.

The next test gave 18.04 for the coal gas, 28.86 for the water gas, and 23.13 candles for the mixture—a loss of 0.32 candle. The last test gave 18.16 candles for the coal gas, 27.84 for the water gas, and 23.24 for the mixture—a gain of 0.24 candle.

While I shall hope to extend these experiments before arriving at my final result, I think the tests already made furnish reasonable ground for the opinion that the illuminating power of mixtures of coal and water gases is practically the same as the average of the two tested separately.

Discussion.

The President—We have heard a very interesting paper by Prof. Love, and its subject is one of great interest to all of us. If any of you desire to ask any questions of the Doctor he will remain on the platform for the purpose of answering. He will be very glad to have you ask him questions, or to hear you discuss the paper.

Mr. R. Norris—I would like to ask whether the candle power tests of the coal gas were made before or after compression.

Prof. E. G. Love—After compression. I presume that the gas suffered a little by compression, but inasmuch as the gas was transferred from the cylinder to a holder, and there equalized itself, it was a matter of no importance at all whether it had suffered a little in illuminating power during the compression.

Mr. R. Norris—Then the analyses were not made after expansion?

Prof. E. G. Love—No; the experiments were entirely separate from the theoretical consideration. I had not time when I made the experiments at the works to make a laboratory or complete analysis of the gases themselves.

Mr. A. C. Humphreys—I would like to ask to what point the compression was carried.

Prof. E. G. Love—The cylinder has a capacity of 225 pounds pressure, and I used a small hand pump. The best result I can get is about 50 pounds; and I think the most that I succeeded in getting in this case was under 25 pounds pressure. That was equivalent to three or four feet.

Mr. C. R. Collins—What was the form of the burner which was used in the test?

Prof. E. G. Love—A flat-flame burner, that known as the Bray. It was the same burner for both coal and water gas. I have used that burner for testing city gas for months, and in that follow the English practice, where they use all cannel. The flat-flame burner is used for ordinary gas, and the Argand burner for gases of 14 to 18 candles. The poorest gas we have is equal, practically, to their cannel gas.

Mr. C. R. Collins—In the course of the experiments which I have made on a practical scale, where we have made a mixture of 10,000 feet of coal and water gas, I have found it necessary to use the Argand burner on the coal gas flame in order to make the resulting mixture the average of the two. Of course there were errors in my work, because the holder was exposed outside, and not under cover; but I made every correction for temperature that I could. It was necessary to use the Argand burner, because we got better results with coal gas from the Argand than we did with the flat-flame burner.

Prof. E. G. Love—What was the candle power of the coal gas?

Mr. C. R. Collins—Eighteen candle power.

Prof. E. G. Love—You used the Referee's burner?

Mr. C. R. Collins—We used the Sugg-Argand.

Prof. E. G. Love—I have followed the practice for a number of years of using the flat-flame burner. A matter of one or two candles (that is, between the 18 and the 18.5 or 20) hardly warranted me in changing my burner. I think I approached nearer the same conditions in testing different gases by using the same burner, and by not introducing a possible difference in the amount of light which might be utilized from the same gas. In exactly the same way marsh gas, when tested by the Argand burner, makes a light of 5 or 6 candles, but when tested by the flat-flame burner gives practically no light at all.

Mr. C. R. Collins—It is generally expected that coal gas will be measured by the Argand burner.

Prof. E. G. Love—In England it is, for that burner is the standard there—but we have no standard whatever in this country—but I think if I were testing coal gas regularly, of from 14 to 17 candles, I would use an Argand burner. When the gas produces 20 or 22 candles, I prefer a flat-flame burner. I know that it is better for the gas.

Mr. C. R. Collins—My errors were all within a candle, and I considered that a pretty fair result.

Mr. T. Littlehales—I wish to ask Dr. Love whether I understood him to say that the carbonic oxide was considered a better vehicle for carbon vapors?

Prof. E. G. Love—That depends upon the way you look at the matter. If you have a little carbon vapor you had better put it with the marsh gas. If you want a whiter light, higher flame temperature, and do not care if you do burn up some of the carbon vapor, then put that with the carbonic oxide. A mixture of ethylene and marsh gas will give light at all proportions of the two. That is, the marsh gas alone, when burned in an Argand burner, will give a light, and consequently all mixtures of marsh gas and ethylene will give light. Now, if you take mixtures of 20 per cent. of ethylene and 80 per cent. of carbonic oxide, you get a flame which, in an Argand burner, gives no light whatever—showing that larger proportions of hydrocarbon are burned up and destroyed when mixed with carbonic oxide, as far as the light-giving power is concerned.

Mr. C. H. Nettleton—I would like to ask Prof. Love if there is any difference in the appearance of the mixed gases; that is, if one was pleasanter to the eye than either gas alone; or were they the same in that respect?

Prof. E. G. Love—I have long ago given up judging of gases by appearance. I did not notice any difference. I thought that they all looked very well, but I do not know that I made any comparison in that way.

Mr. C. H. Nettleton—The reason I have for asking is that there is a feeling, or a belief, among a great many people, that the best gas is made by a mixture of one-half coal and one-half water gas. That may be simply a whim, but an incident which came to my knowledge rather bears out that idea. Several years ago, when the lines were drawn very much more strictly than fortunately they are now between coal gas and water gas men, a coal gas man was brought into a room where there were three burners, one of which was good water gas, another was good coal gas, and the third was a mixture of the two; and he was asked to pick out the kinds of gas. Pointing to the mixed gas he said, "There is no use talking; the water gas makes the best light." Certainly, in my own experience the most beautiful gas—I do not mean the most brilliant, but the pleasantest to my eyes—was a mixture of the two gases.

Prof. E. G. Love—There is a blueness visible about the lower part of a pure water gas flame which is somewhat overcome by the admixture of coal gas. That may possibly have something to do with your impression.

Mr. F. Egner—I remember a time when it was rank heresy to see anything good in water gas, but I believe I may state now, without any fear of contradiction, that a mixture of coal and water gas always struck me as giving the brightest light. People who did not know the kind of gas they were looking at, would admit that much; and I believe that to-day water gas gives the whitest and prettiest light.

Mr. A. G. Glasgow—I was engaged for several years in the manufacture of mixed gas. I made about 40 candle power water gas, which was mixed with 17 candle power coal gas, in such proportions that the resulting mixture gave 27 candles. Now I am satisfied that in practice I got a higher luminosity than the calculated average of the two gases. In fact I made experiments, not perhaps carefully enough, but sufficiently so, I believe, to justify me in that conclusion. It occurs to me that the relative candle powers of the gases that are mixed make a considerable difference in the result. Perhaps my water gas was too fat to stand alone. I never calculated its flame temperature, but I am satisfied that it contained more hydrocarbon than could be burned advantageously at its flame temperature. When mixed with the leaner coal gas, my idea is that the flame temperature was such that combustion took place under conditions more favorable to luminosity.

Prof. Love—I think that is very true. Of course you can readily appreciate that there is a neutral point—that there is just the right point somewhere between the two, and if you strike that you can get the best possible result. You may get so high a flame temperature that you burn up all your hydrocarbons, and they are lost; on the other hand, you may get a sufficiently high temperature to let a part of the carbon particles escape as smoke, and consequently that is a loss. If you can get between the two you will have what I think is perfection in the way of flame.

Mr. F. Egner—I was speaking about the illuminating power of gas. I suppose nearly every one knows this to be the fact, that a difference in the burner makes a great difference in the illuminating power of the gas that is burned. If gas companies everywhere would take a little interest in the matter, would look at their consumers' burners, and instruct consumers as to the best kind of burner to use, a great many complaints about poor gas would cease. We know, as I have said, and everybody knows, that a difference in the burner makes a great difference in the illuminating power of gas. I believe that every company ought to try to instruct their consumers in this respect. The inspectors ought to look at burners occasionally, and it would tend greatly to reduce the complaints about poor gas.

Mr. W. R. Addicks—Following in the line of what Mr. Egner has just said, the difficulty in the suburban districts around Boston has been exactly what he says. There the gas fitters invariably put on a three-foot burner in order to save gas for consumers. The whole complaint we had from consumers on the introduction of water gas was on account of the small flame. The point that I want to make is this. In the mixing of coal and water gas I think it is possible that the specific gravity may be increased in greater ratio than the illuminating power, and in that way the burner would be better adapted to pure coal gas, perhaps, than to the mixture in use, and would cause complaint. We found that the removal of the three foot tips and substituting five-foot tips invariably gave satisfaction.

The President—Recently, while visiting the St. Paul Gas Company, I was struck with a circular hanging in front of the cashier's desk, giving some lithographic cuts of bad burners and of good burners, with the same gas—showing our old friends, the many forked and many tongued gas burners in several different phases; and alongside of it a photograph of a perfect gas burner. This seemed to me to be a very practical way of calling the attention of consumers to the difference between good and poor burners. These circulars were sent to every customer of the Gas Company on the presentation of his bill; and I was very much pleased to be informed by the manager of the Company that they had worked a wonderful result. He also said that the Gas Company would send and put on new burners of the kind shown in the picture, at no cost to the consumer. He was much surprised to see how much interest the consumers took in the matter when it was brought to their attention.

On motion of Mr. Nettleton, a vote of thanks was tendered to Dr. Love for his paper.

Telegrams to and from the Association Hall.

The President—Is the Committee appointed yesterday to send telegrams to our sick brethren ready to report?

Mr. E. G. Cowdery—The Committee sent the following telegram to each of the three parties named—Mr. Humphreys, Mr. Harbison and Mr. Goodwin:

"The American Gas Light Association wish to tender you their sincere sympathy in your long continued illness, and their great sorrow at your enforced absence from the present meeting, which they know so well you would thoroughly enjoy. The entire Association extend to you their wishes for your speedy recovery. Signed, American Gas Light Association, per Committee."

To that telegram the following message has been received from Mr. Goodwin:

"Kindly say to the American Gas Light Association that their telegram of sympathy and condolence was received by a grateful

heart. I was feeling awful blue, thinking of my inability to be with them, when it was received, and their kind remembrance acted like a panacea and makes me the more determined to get well and live.—Goodwin."

I believe that Mr. Harbison will reply to his telegram in person. No answer has yet been received from Mr. Humphreys.

COMMITTEE TO PREPARE A SOUVENIR TO THE RETIRING SECRETARY.

Mr. T. Littlehales—In connection with this matter I would like to move you that a committee be nominated to prepare an address from this Association to our former Secretary, Mr. C. J. R. Humphreys, expressing the regret of the Association at losing his services, their sympathy with him in the sufferings through which he has passed, and their hopes for the future; and that such address as the committee may think well to prepare be engrossed, and then be presented to him as a souvenir of his connection with the Association.

The motion was seconded by Mr. E. Betts, and unanimously adopted. The Chair appointed as such committee, Messrs. W. R. Addicks, Walton Clark and Charles H. Nettleton.

Mr. David Douglas, of Savannah, Ga., then read his paper, on

THE MANIPULATION OF TAR FROM CARBURETED WATER GAS.

The utilization of the residual products from coal gas works has been an important factor in enabling coal gas engineers to make a better quality of gas at lower prices, and the virtual absence of residual products in a water gas plant has frequently been pointed out as an objection to that system of gas making.

The only valuable residual in a water gas plant is the tar, and the fact that it is the only one should make us take all the more care of it and endeavor to get as much return from it as possible.

In the earlier days of water gas the tar was looked upon as valueless. Where possible, it was allowed to run into the sewers and water courses, and in some instances the disposal of it was a source of much trouble. I believe there are some water gas works yet in existence where the tar is allowed to run to waste, but in the majority of works they have found that it has a value.

When water gas was enriched with naphtha there was very little tar to take care of, and that I imagine was of inferior quality. The use of heavier distillates increased the quantity and density of the tar, and the use of crude oil as an enricher has still further increased the quantity of tar made per 1000 feet of gas, and has I believe much improved its quality.

It is possible, I think, to show that the careful collection and subsequent manipulation of the tar from a water gas plant can be made to exercise an appreciable influence upon the balance sheet of a company using the water gas process.

In the examination of water gas tars, we will notice that they are not all alike; there will be variations due: (1st), to differences in the quality of the oil; (2d), to differences in methods of gas making; large and highly heated superheaters would naturally yield a denser tar than small superheaters and low heats; (3d), the quality of tar will vary according to the point at which it is collected in the works; heavier tar will be found in the wash box and condensers and lighter tar in the scrubbers and drips in the works.

The oil which I have been using at Savannah is Lima crude oil of about 38 deg. Beaume; and all experiments recorded in this paper have been made with tar produced from this oil.

Our superheaters are rather too small, but we do not run them at higher heats to compensate for their lack of size. We endeavor to get as much heat as will fix the oil, but if there is a doubt of the exact shade of heat required, we prefer to work on the cool side and make more tar, which is easily collected and which can be worked into value, rather than make lamp-black, which chokes up everything and is a dead loss of oil besides.

In Savannah, prior to 1888, we had been using naphtha and other distilled oils and the tar was allowed to run to waste. We then commenced to use Lima crude oil, when the quantity of tar produced made it imperative that it be taken care of; if for no other reason than that we would soon have been threatened with proceedings by the harbor authorities. Doubtless our trouble was aggravated by the smallness of our superheaters, and the quantity of tar we now make in Savannah may be in excess of that made at other works, where better proportioned plants with large and properly constructed superheaters have been put in, with a special view to using crude oils.

We were then using about 4.8 gallons of oil per 1000 feet. Dipping the tar well showed that we were making apparently nearly 1 1-4 gallons of tar per 1000 feet of gas. The quantity of tar appeared to be enormous, and unexplainable. I sold it in its crude condition to a manufacturer of naval pitch, and we got a good price for it. It appears that he stirred the cold tar into a mixture of hot resin products, and I understood that the quality of the article thus produced by him was highly satisfactory. Complaints soon became frequent that our tar was two-thirds water. Next we heard of trouble from the foaming over of his hot mixtures, and, lastly, that the foam had run over, caught fire and nearly burned up the factory, and the trade ceased entirely.

Investigation showed that the tar in its crude state was really unfit for sale, because of the excessive quantity of water held in suspension, and the water would not separate from the tar in the tar tank.

Meanwhile the tar tank was filling up rapidly, and as we dare not allow it to run into the river, I was driven to look for some other solution of the difficulty.

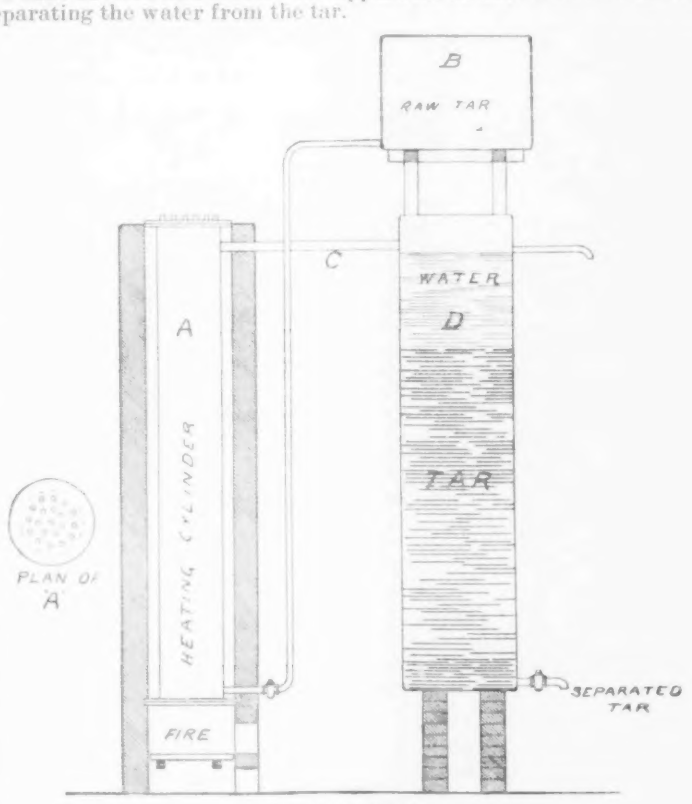
I will not attempt to give an account of all my experiments and failures, but only relate such points as appear to be of interest.

I set up an old boiler shell on end and placed a steam coil inside of it. In this I heated the tar to about 180° F. and maintained this temperature for some hours. There was a partial separation of the water, but very slight, and the tar was still unfit for use.

I next placed some raw tar in an open caldron and fired very carefully, stirring it steadily as it approached the boiling point. The result was that just as soon as it began to boil it foamed up briskly, overflowed the caldron, got into the fire and soon was a mass of flames. I was prepared for this contingency so no damage occurred.

I afterward tried a smaller quantity in the caldron and, by avoiding stirring, the tar got a condition of ebullition without foaming. A thermometer placed in the boiling liquid showed 232° F., and the water was assumed to have gone; but when the boiling ceased I found that about one-third of the quantity left in the caldron separated and formed a layer of water on the top of the tar. It struck me as strange that I could boil a mixture half tar and half water in an open vessel to a temperature 20° higher than the boiling point of water and yet the water was not being driven off rapidly, neither was there any foaming worth noticing. The mixture was doubled in bulk by the heat and it was all in a state of apparent ebullition. On examining the boiling mass more closely I observed that small bubbles about the size of a pea or less were constantly rising to the surface. Some of these burst and disappeared, others seemed to shrink and be carried down again into the boiling tar. I came to the conclusion then, and further experiments have confirmed me in the view, that the water is held in the tar in the form of small globules, each of which is encysted in an envelope of tar. These globules are so small that they are not heavy enough to overcome the viscosity of the enveloping tar. In the boiling operation already mentioned it was shown that part of the water of each globule was converted into steam and the envelope distended into a bubble which rose to the surface, where the bubble burst and the water which was in the form of steam escaped into the air, the rest of the drop being carried down again by the rapid circulation in the caldron, to repeat the operation until finally it disappeared. In other cases, if the bubble stayed long enough on the surface to cool slightly, it contracted by the condensation of the steam and went down to try and do better next time. It is evident that evaporation of water from the tar under such conditions would be exceedingly slow. If at any time while the tar was thus boiling steadily one attempted to stir it, the whole mass would immediately rise into foam and overflow the caldron. The hot tar (230° to 235°) was brought more closely into contact with the water at 212°, and steam generated so rapidly that foaming was the natural result. Noticing that, on allowing the fire to slacken and the boiling to cease, the tar and water separated and formed into layers, I tried to get rid of the water in that way, but did not find it practicable to do it in the same vessel. I found that I had three layers, viz., tar in the bottom, water next and a scum of oil on top. To boil off the water under such conditions was too tedious for anything.

I next devised and erected the apparatus as shown on sketch for separating the water from the tar.



VERTICAL STILL.

A, is a cylinder with as many 1 1-2 inch pipes as could be conveniently placed in it to be used as flues. Raw tar is regulated to flow in from the tank B. The tar is heated in A, and rises in the form of foam and flows through the pipe C, into the settling tank D, where the water and tar separate, the water passing off through the overflow pipe E, and the separated tar, ready to be distilled, is drawn off at F.

This apparatus I have been using for over a year and it does the work fairly well, but it is neither a very efficient nor convenient arrangement. The tar still contains from 7 to 9 per cent. of water. In this condition it might be used for some purposes, but it is too thin to be used as coal tar ordinarily is used. I could not sell it in Savannah.

My next step, therefore, was to distil the tar in a common cylindrical boiler and thus drive off all the water and as much of the lighter oils as would bring the tar to a proper consistency for commercial purposes. To do this the distillation has to be carried on until from 5 to 8 per cent. of the volume of the tar is obtained in the form of oil, and the temperature of the tar in the still is about 400 deg. F. If heavier tar is wanted a longer distillation will give it, and if desired the distillation can be carried on until the residuum in the still consists of a hard pitch, the temperature in the still at this last stage rising to about 600 deg. F.

The oils obtained from the distillation of oil tar do not resemble those obtained from coal tar; neither are they in appearance at all like the distillates from crude petroleum. I show here a series of samples of oil taken from a careful distillation of tar up to hard pitch. The lightest oil is 30 deg. B., and the heaviest is heavier than water. It is noticeable that all the oils, even the heaviest, are very fluid and have no greasy feel whatever. Beyond the fact that a good deal of naphthaline comes over at certain stages of the distillation, I am not able to say anything about the chemical constituents of these oils. We send them all back to the crude oil tank and they are used again in gas making. I am in hopes that some better value may yet be found for some of them. The lighter oils are pretty good solvents for India rubber, although not equal in this respect to coal tar naphtha.

The distillation, of which this set of samples is a fair exhibit, gave:

Water	8.56	per cent.
Oils	44.55	" "
Hard pitch	43.84	" "
Unaccounted for	3.05	" "
Total	100.00	" "

While examining this tar during my experiments I was attracted by its beautiful glossy, black appearance. It seemed to be almost free from lamp-black. The thickened tar was exceedingly viscous and could be drawn out into threads as fine as silk when lifted on the end of a stick. Every indication showed it to be of a superior quality to coal tar. A recent analysis of water gas tar, made by Dr. Woodman, of New York, gave 4 1-2 per cent. of lamp-black.

As we had not been making tar for sale for some years, the demand for the tar when made was at first very slow. I, therefore, began some experiments in the manufacture of an asphalt which could be used for sidewalks and light pavements, hoping thus to make a market for the tar. I investigated the formulas of as many manufacturers of asphalt as I could get. The best of them, so far as I could judge, used varying proportions of refined Trinidad asphaltum; heavy petroleum oils; pulverized carbonate of lime, and sand.

A proportion of partly distilled coal tar was used in some instances, but my idea was that none of the manufacturers cared to impress probable purchasers with the idea that coal tar was largely used in their material.

It seemed to me that prepared water gas tar was about as good a substance as Trinidad asphaltum, and by stopping the distillation at the proper stage there need be no subsequent addition of heavy oils. I had a pretty good substitute for pulverized carbonate of lime at hand in the form of gas lime, and sand is abundant.

The making of a fine street asphalt was not contemplated. My efforts were to make a cheap asphalt which could be mixed in the gas works yard and hauled out and laid anywhere when cold. I proposed to have the article ready-mixed in the yard, and sell it by the ton to such as might have occasion to use it. As resin is a cheap article in Savannah I was tempted to use some of it, because it stiffened the tar and saved time in the distillation. I do not, however, recommend its use. It is an inferior material and detrimental to the durability of anything it is mixed with.

After many trials and failures I at last produced a very fair asphalt which answered the purpose. Its composition was

Tar	20	per cent. =	400	lbs. per ton.
Resin	10	"	200	" "
Gas lime	50	"	1000	" "
Screened ashes	20	"	400	" "

The gas lime and ashes had to be heated and the resin and tar melted together, and a thorough mixing was essential. A better article could be made by using sand instead of ashes, or even a proportion of sand, but sand cost something and I had plenty of ashes in the yard.

I got an order from the city authorities for a trial lot. They graded the ground very nicely with oyster shells, well rolled. One ton of the asphalt covered 25 sq. yds. of surface, and it was fit to walk upon as soon as it was rolled firm and smooth. The work was perfectly satisfactory and I received further orders at a fair price, but it was evident that we were not making enough tar to meet anything like the amount of business which could be developed in this direction. The demand for tar in other directions improved and I abandoned the asphalt business.

I felt all along that this water gas tar is of too good a quality to be used only for such rough purposes as coal gas tar is generally applied to, so I turned my attention to making a black varnish which would bring a higher price for my tar than if sold simply as tar. What I sought to make was a bright, glossy varnish which would dry reasonably quick, and when dry would not scale off, but would retain a certain amount of plasticity without becoming tacky under a little excess of heat. I think we at last managed to make a pretty good material. I have samples here to show its appearance.

We use this varnish for our gas meters and find it superior to anything we had been in the habit of purchasing. I also sell it for coating cotton ties, *i.e.*, the hoop iron bands which bind the cotton bales. These are subjected to a good deal of strain and twisting. If they rust they are apt to stain the cotton, and if they are tacky the men would object to use them. This varnish quite fills their requirements, and they say is better than the regular asphaltum varnish they had been using hitherto.

My formula for this paint is very simple, but I think I tried every kind of mixture before I got it.

In distilling the tar we run long enough to get rid of some of the heavy oils leaving the tar pretty thick. Take crude rubber and dissolve it in some of the lighter distillates from the tar. Mix the dissolved rubber with the heavy tar, adding enough light distillates to thin the mixture to a proper consistency to work easily with the brush. Half a pound of rubber is sufficient for 50 gallons of varnish.

The one great difficulty in the manipulation of water gas tar, is the initial one—to separate the suspended water from the crude tar.

In gas works where both coal and water gas is made, and both tars are run into the same tar tank there is probably little or no trouble from this cause. I have had some experiments made which show that where crude water gas tar is added to an excess of coal tar, the water gas tar is absorbed into the coal tar and the suspended water is liberated to a very considerable extent, but in all works where water gas is made exclusively, I believe this mixing of the water and tar is found to be a practical trouble.

I have already described the somewhat simple apparatus I have been using for the dehydration of the tar, and have said it was not thoroughly satisfactory.

Dr. Woodman, technological chemist, New York city, has been kind enough to make a pretty thorough set of experiments as to the dehydration of water gas tar, and has thrown a good deal of light upon the subject. I will venture to give a few extracts from his report. He says:

"The application of heat to oil gas tar, even up to 212° F., not only fails to cause a separation of the water contained but seems to actually perfect the already existing emulsion, and the tar thus treated remains unchanged for days and weeks. * * * When subjected to distillation the water and oils separate; but, owing to the almost uncontrollable tendency to foam, the process becomes almost impracticable."

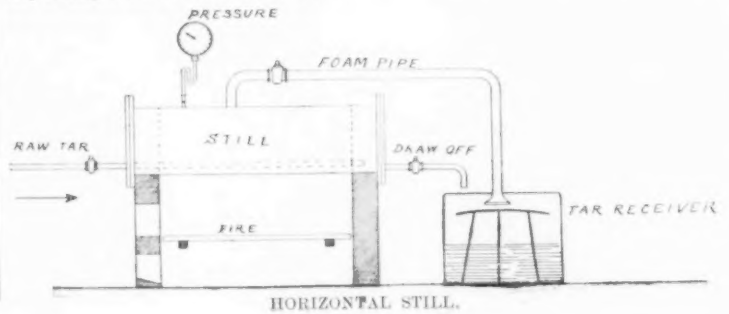
To tar containing 50 per cent. of water, Dr. Woodman added 50 parts more water, forming an emulsion, and after waiting three days no water had separated. To this he added 25 parts more water, making a total of 125 parts, and after standing six weeks 25 parts of water could be poured off, after gentle agitation, to collect the separated portions. "This," says Dr. Woodman, "indicates a strong tendency to form an emulsion with water, regardless of the special conditions existing in the gas-making process."

Dr. Woodman's experiments led him to try the addition of nearly everything which could be suggested, but with very little effect upon the adhesion of the water and tar. The only substances which had any appreciable effect were a strong solution of potash and cotton seed oil. Again I quote from him. He says: "The addition of light hydro-carbon liquids, of tar oils, crude petroleum, of acids or salts having an acid reaction, is of no utility whatever. The addition of 5 per cent. potash solution and 5 per cent. cotton seed oil effects the separation of most of the water, *provided* the temperature of the tar is not above 60° F.

"The addition of 5 per cent. cotton seed oil permits of a quiet distillation."

Dr. Woodman's experiments seem to demonstrate that the addition of chemicals to the tar was of little value in its dehydration.

Just before leaving Savannah I made another effort to effect this separation of the water in a simple mechanical manner, and this time I have come nearer to the solution of this problem than by anything I have hitherto tried.



HORIZONTAL STILL.

In this experimental apparatus the still consists of a plain cylinder, fired in the ordinary way. The raw tar is forced in by a pump, a steam pressure gauge is placed upon the still. There are two outlet pipes, one from the top, which I call the "foam pipe," and which is provided with a wire gauge screen at its outlet, and one from the bottom of the still, which I call the "draw-off" pipe.

Tar being pumped into the still, and fire applied, the tar, of course, foams up. The outlet cocks are kept closed until the pressure on the gauge shows about 25 lbs. The foam cock is then opened, and the foaming tar allowed to flow gently into the receiver. The bubbles are supposed to burst in passing through the wire gauge, but if any do escape, the falling upon the baffle plate in the receiver is supposed to burst them. Any tar or water which separates in the still is removed by the draw-off cock. Meanwhile, fresh tar is being pumped in, and the whole process becomes continuous. My impression was that most of the water would come off through the foam pipe in the form of steam, but I find that a considerable proportion of the water in the tar is separated in the still itself, and can be removed at the draw-off pipe. Two tests made with this apparatus gave the following results:

Test No. I.

Dehydrated tar in receiver,	46.5 per cent.
Water collected,	24.5 " "
" evaporated,	29.0 " "
	100.0

Test No. II.

Dehydrated tar in receiver,	51.0 per cent.
Water collected,	24.0 " "
" evaporated,	25.0 " "
	100.0

Subsequent distillation of this dehydrated tar showed that, practically, all the water had been removed; less than one per cent. of water was found in it. It appears to me that this apparatus indicates a solution of this troublesome problem.

Just how much tar is made, or should be made, per 1,000 feet of gas in a water gas plant using crude oil is a question I am not prepared to answer. He would like now to put all the oil into the gas, and make no tar at all; but if tar should prove to be worth more per gallon than crude oil, we may yet change our minds in that respect.

In 1888, when using about 4.75 gallons of oil per 1,000 ft., we made about .6 of a gallon of tar per 1,000 ft., not counting the water in the tar.

In 1891, using about 4.5 gallons of oil per 1,000 ft., we make about .35 of a gallon of tar per 1,000 ft. Of this, .1 of a gallon goes back to the oil tank in the form of distillate, and the tar made for sale amounts to just about one-quarter of a gallon per 1,000 ft. of gas made.

These quantities appear trifling in amount, but if we can only demonstrate that the water gas tar is of superior quality, and in consequence can find a market for it at a higher price than we hitherto set upon it--and I think we can—then a quarter of a gallon of tar, if worth 20 cents per gallon, would give us 5 cents per 1,000 feet. Figuring at any price in these days of keen competition, when every fraction of a cent has to be counted, it is evident that we cannot afford to despise our residual of tar from a water gas plant.

President Harbison Arrives.

When Mr. Douglas had finished reading his paper, the presence of President John P. Harbison was discovered, and a prolonged round of applause greeted him. Vice-President White (stepping aside from the Chairman's table) then said:

"Before proceeding to take up the discussion on the paper just read by Mr. Douglas, it is my very great pleasure and privilege to announce that at last we have with us our President, Mr. John P. Harbison. (Applause.) Mr. Boardman will please present our President. (Mr. Harbison was escorted to the platform by Mr. Boardman). I now have the pleasure of turning over the gavel (and I know you join with me in that pleasure) to our chosen President, Mr. Harbison."

President Harbison—Fellow members of the American Gas Light Association: I cannot tell you what my feelings are at this moment, or what they have been during the past few weeks, while I have been conscious, in regard to this meeting, and the privilege of meeting with you, or the prohibition by my physician that I must not come. A week ago, yesterday, he gave me that permission under certain conditions. Those conditions I have complied with to the letter, and I propose to; so that my stay with you to-day will not be very long. As I crossed the walk yesterday from my office door to my carriage to take the train, a messenger boy put into my hands a despatch from my brethren of this Association. It pretty nearly unmanned me. I knew I had the regard, and to a degree the affection, of many of the members of this Association, but to have a message in the language in which that was couched was too much for me. Brethren, my heart responds to your sentiments. I feel grateful, and can simply say in connection with it, God bless every member of this Association.

Three weeks ago, or more, in answer to an earnest inquiry of my physician, he positively forbade me thinking of the business affairs of this Association, and said I must not think of committing anything to paper as an address to be delivered to you. As soon as I was able I wrote to my beloved friend, Capt. White, your President-elect, and turned the business of the Association over to him so far as the President's duties were concerned.

As some of you well know, a year ago, when you were kind enough, and generous enough, and compassionate enough with yourselves, to elevate me to this honorable position, my beloved brother and friend, C. J. Russell Humphreys, consented to serve as Secretary for this year, only as a personal favor to me.

We journeyed together to Zanesville, in March, to attend the Ohio meeting. We journeyed together to Louisville, in May, to attend the Western meeting. Soon after our return that beloved brother was laid on his back, and some of you may know how near the point of death he has been, and he is still unable to be with us. Thus your two executive officers have been within the year unable to perform their duties.

It became evident a week or more before I was taken ill that Mr. Humphreys could not be with us to do his duties. His worthy and efficient brother volunteered previous to that, and at that time, to help us in any way he could, even so far as to undertake to perform the duties belonging to the Secretary. I at once sent him an official appointment, as Acting Secretary and Treasurer, to serve until his successor was elected and qualified. How well he has performed that duty on a moment's notice you all know. It is not necessary for me to allude to it. Probably no other member of this Association—I doubt whether there is a single one here—could have performed that duty as Mr. Alex. C. Humphreys has done. (Applause.)

There are two or three things that I would like to say to you. The members of this Association will bear me witness, that since its organization, or very soon after its organization, when I became a member, until a year ago in Louisville, no member of the Association in Association meetings, ever heard me say a word that was particularly favorable to water gas. I had been conscientious in my views. I knew what I was doing with coal gas. Water gas to me was theory, and somebody else's results. Practically, I knew nothing about it. At the Louisville meeting it became known that I had recently, or a little while before that time, put in a water gas plant. I had only started it ten days before I went to that meeting. I could not give any results, and I was hardly ready to tell why I had done it; but I promised the Association then that if I lived until this meeting and attended it, I would tell you my reasons and general results; and I like when I make a promise to keep it. That was one very strong point in urging on my physician that he should permit me to come down here and be with you an hour to-day. We have in our city, as many of you have—some of you owning it yourselves and some of you competing with it, the plant being owned by other parties—electric light plants. The American people are great for new things; and when the electric light came around they went for it, and went for it pretty strong; the gas companies suffered in consequence. We did to a considerable extent. We lost our entire street lighting. We have not a street lamp left, and have not had one for two or more years. A large number of private consumers introducing the electric lights, put out gas. It became necessary to meet that competition. Economy was introduced at every point where it could be in the manufacture and distribution of gas. The very best results that might be obtained we tried to get, and we thought that we were doing well; but the light from the new electric lamps would outshine the gas that we could make from coal. I introduced naphtha as an enricher instead of cannel coal to whiten the light. I was not able to get above 18 candle power, and not smoke. As against the 25 or 30 so-called candle power incandescent light, gas would not compete. They put in their lights by contract, the prices being the price at which gas was sold the previous year, and people could use it all they wanted. We lost a large number of our consumers. It became evident to me that something more must be done. I had had various parties with me urging that I put in a water gas plant. One distinguished man in the business called on me and urged me, as he had done several times before, to introduce it, but did not succeed, my statement to him being, When you can demonstrate to me the saving of ten cents a thousand cubic feet, with the receipts for the dividends filed in the safe (for that is where my expense ends in making and distributing gas) better than I can do with coal gas, I am ready to consider a contract with you. That gentleman has not, to my knowledge, been in Hartford since, and that was six or seven years ago. I put in a stack of regenerator benches, which you all know of, for I have told you of it before. I got good results from them, and they are doing well. A representative of a large concern engaged in the introduction of water gas called upon me in the line of business, and wanted to call my attention to their system of making water gas. He stopped at my up-town office, and talked with me there. I said to him, Before we talk business, come down with me to the gas works and see what we have got there, and what we are doing, and see our books. Let me show you what our gas has cost us to deliver, what results we are getting, what our candle power is, and then tell me what you can do for us with your system. He did so. He is a member of this Association. He is in the room to-day—and second to no other member in intelligence and activity. When he had examined the works carefully over, he said, "I will return to my superior officer, and tell him that there is no business for him in Hartford." I continued my investigation with regard to what was being done with water gas; and I became satisfied that we could make an improvement in our business by the introduction of a water gas plant, not by any means discontinuing coal gas, but to make a mixture of the two gases. A

year ago last spring we made a contract for a plant having a capacity of 500,000 cubic feet guaranteed. We are making to day, and every day, more than 325,000 feet in 24 hours with *one-half* of that apparatus in use. We have made, and used that gas every day since about the first of October a year ago. We make the two gases. As the water gas comes in a crude state from a relief holder it passes through a station meter, which we bought for the purpose of measuring what we were using, and connected it with the take-off pipe from the hydraulic main, at a distance of 40 feet from the hydraulic main, and there unite the two gases before they reach the exhauster. We have wintered that gas and have summered it. We have had a change of 40 deg. of temperature within 24 hours. We have increased the candle power 23 per cent. over what we were doing with coal and naphtha gas, using naphtha in the retort, and I have not seen the gas in my office (half a mile from the works) in a Jones photometer below 22 candles in a year, varying from 22 to 23 1-2 candles. Two years ago, when we had trouble with our gas, the city had an inspector appointed, and the inspector has made monthly tests and reported to the Common Council every month since that time, until the meeting that was held a week ago Monday night. His last test was made on the 30th of September. On his report being read, it was unanimously voted by both branches of the Council that the services of the city inspector be dispensed with, that he make no further test; that the quality was so good, so uniformly good, that there was no necessity for it, and they need not be at the expense. I knew nothing about it. I had then been in a sick bed for more than a month. Therefore, that vote was not carried through by any log rolling on my part, or any knowledge on the part of any member of our Company that such a thing was proposed. There is not a consumer in the city of Hartford within my knowledge that is not entirely satisfied with the quality and with the service. We have increased largely since the first 60 days after we put in the water gas, the increase being continual and regular. I believe that the mixture of the two gases makes a gas and makes a light that is superior to either coal or water gas alone, and increases the light without making a smoke. We have not had a complaint of the smoke from a consumer, to my knowledge, in 12 months, where the burners were good, and I do not believe there will be any. We have not had, until the very cold weather of two weeks ago, within my knowledge, a complaint of naphthaline in any service of the city during the time we have been using water gas. We had a very severe cold spell ten days ago, and I was informed that some five or six cases had been reported where there were slight stoppages by naphthaline at the meters.

These are some of the results that we have obtained in the year; and we believe that any company that wants to furnish the very best light to its consumers cannot do better than put in a water gas plant, to be used in connection with its coal gas plant, and use the two together. I believe such will find it profitable for themselves, and greatly beneficial to their consumers.

We are selling coal tar to-day, and have been all through the summer (excepting a contract we made at the beginning of summer with a party that we have served for 40 years, they paying us $3.25 per barrel) at $5 per barrel, and have not been able to take the orders that have been sent us at that price. We have sold coke at six cents per bushel for years. We are now selling, and have been for ten months, at ten cents per bushel.

These are some of the results that we have obtained. We believe that we are running our plant fairly well; at any rate, the chief executive officer of the Company who put in our apparatus for us has informed me that he had not in mind then any party that showed any better results with his apparatus than we were obtaining.

Brethren, I now have redeemed my promise made to you a year ago, and if my experience is of any value to any of you I shall be glad of it. (Applause.)

Installing the Officers Elect.

The President, continuing—Will the Secretary kindly inform me of the result of the election of officers on yesterday? If there is anything that has been a burden on my heart while I have been ill it has been that I could not be here to declare the result of the election of my successor, and to properly introduce him to the members of this Association as your choice to preside over your destinies during the coming year. I knew what your choice would be. It could not be otherwise. By your kindness in postponing the introduction of officers-elect till to-day I have the pleasure of making this introduction. I learn that during your meeting yesterday you had the pleasure of adding something like 50 names to your list of membership. It is particularly gratifying to me to hear of this large increase of active, energetic, intelligent, working men to the ranks of the American Gas Light Association. To those who have been members heretofore, your selections of yesterday need no introduction, but to the new men who come in for the first time with us, your selections of officers need an introduction, in part at any rate. That is one of the pleasant features of this Association. While I have been so ill, that has been one of the great comforts to me—that my acquaintance was so pleasant with the members of this Association, as with those of all the other Associations with which I have the honor of being connected, that we are as a band of brothers, all striving together in the same cause. When this Association was organized I doubt if there are half a dozen men in this room who could have gained an entrance into the Manhattan gas works of this city, or into any gas works of any other city. They would have found the gates locked, and a flaming sword there to keep them out. Now every gas works in the land that I know of is open to any man who is a gas man, and a member of this Association, on his presenting himself, and saying who he is, if he is not already known. Our books are at the disposition of each other, and all the information that we are possessed of is cheerfully given.

I find by the report of your doings yesterday that your Committee on Nominations presented the following names for your consideration, and that you unanimously, through your Secretary, passed the ballot of the Association for the names presented.

If there is any man in the profession who does not need an introduction to you, that man is Captain William Henry White. (Applause.) Brethren, I know William Henry White as few of you do. He has been an intimate friend of mine for many, many years. I have traveled with him, and slept with him, and I know him thoroughly. He is a man without a weak point as a man, and as a friend; a man who has never been known by any gas man, or by anybody else within my knowledge, to know of or to meet a man that was in need of assistance, or of a word of advice, but his hand was open, and his heart was open, and his pocket was open to relieve him, and to help him to the extent of his ability. His name is proverbial for good things amongst us; and this Association has done itself honor in calling to the office and position of its President Captain William Henry White. I would have been willing to have counted the railroad ties between Hartford and New York, and to have walked here rather than had any member of this Association have the honor of introducing him to you as your President-elect other than myself, I being your President; and I would be willing to put in another four or five weeks in bed, if it was necessary (as I trust to God it will not be), to have this honor, which now, and now only, can come to me. I have now, without any further remarks in regard to it, the extreme pleasure and personal gratification of presenting my beloved friend, and your friend, William Henry White as your President elect.

Response of Captain White.

President elect White:—*Gentlemen*—As our President has said, I feel that I need no introduction to you. And I may rightly deem this to be sufficient response to the words spoken by your President, and in recognition of the honor you have put upon me. The full heart may not be relieved of its tension through the agency of the voice, and were I to talk to you a thousand years I could not give you even an idea of how proud I am to at last fill the highest position in your gift, feeling, as I well do, that I have not won it through any great merit as an engineer, and that no man who sits within the sound of my voice considers me in the light of a great professional success. But as your friend, as your comrade, as one who, sometimes with a heavy heart, never permitted his trouble to weigh upon your liveliness, I feel that you have arrived at the conclusion which we are told sometimes is arrived at by woman who, in order to get rid of an importunate lover, marries him. So I think you have concluded at last that you have had me in the guise of king's fool long enough; that if it were possible for me to have a grave and serious moment you would lift me to the dignity of the place to which you have chosen me, and say, "Stand there, little fool; look wise if you can; rattle your cap and bells as you may, but remember the king's eye is always on you."

I shall try, brethren, to fulfill the duties of this office with that fairness which springs from the desire to serve you faithfully, and all that I ask in further favor at your hands is to guerdon me in that earnest support with which you have so staunchly sustained my predecessors in this office of honor and responsibility.

President Harbison—Brethren of the Association: You have made one step further in progress, and have promoted to the first Vice-Presidency a man whom we all love, a man whom we all admire, a man who has served the Association in season and out of season since he became a member—a man eminently qualified for the position to which you have called him, and from which a year from this time, if he is alive and is spared, you will promote still further. I have great pleasure in introducing to you our brother, A. E. Boardman, of Macon, Georgia, as your First Vice-President elect. (Applause.)

Response of Mr. Boardman.

Mr. A. E. Boardman—Gentlemen of the Association, and fellow brethren of the craft: I have very little to say, except to thank you for the promotion which you have given me, and to thank our worthy President for the kind words in which he has introduced me. Some men inherit greatness, others acquire it, and others have it thrust upon them. I belong to the latter category. I assure you, with all my apparent bravery, it is with extreme diffidence that I accept a position of such honor and trust in such a body of men, feeling as I do that I do not deserve it, and that it is given me because I represent a section of this country which we all feel is a common country; and because I was one of the first from that section to come to your notice on account of my glib tongue. I thank you for your kindness in electing me, and I promise to do the best of my poor ability to merit your esteem. (Applause.)

President Harbison—You have gone one step further, and although when this Association was organized it was confined to gentlemen connected with the profession within the territorial limits of the Star Spangled Banner, since that time, in a feeling of brotherly love and kindly regard for our neighbors, and because

our neighbors were good fellows and able and capable, and we wanted them of us, and they, in a generosity and kindness of heart, wanted to be with us and to do us good, and to get good from us; we have gone over the line to take in a number of our brethren from over the border, and it will be but a short time before they will all be with us in fact. (Applause.) You have called to your Second Vice-Presidency that eminent gas engineer, that man who is always ready to do his full duty, always in attendance at our meetings, always taking active part in them—brother William H. Pearson, of Toronto. (Applause.)

RESPONSE OF MR. PEARSON.

Mr. William H. Pearson—Gentlemen of the Association: When you so very kindly, in my absence last year, elected me to the honorable position of Third Vice-President of this Association, I felt as I can hardly now express. I was exceedingly grateful for the high honor conferred upon me. I thought that after having elected me to that position I would have gone no further and be quietly allowed to retire to the ranks of the Association; but when you yesterday so kindly elected me to the position of Second Vice President, while I felt extremely grateful for it, I must confess I experienced a feeling of very great trepidation as I thought of what might possibly follow. I do not accept this as a position given to me because of any particular merit in myself, but rather as an act of kindly consideration and as an act of brotherliness toward the country to which I belong. (Applause). I thank you that you have done this honor to Canada, and as such I accept the honor, and not as a personal matter. I do not consider that my attainments, that my work entitle me to such a position, but I accept it for the reason that I have just stated, and I assure you I shall perform any duties in connection with that position that may be given to me, to the very best of my ability.

President Harbison—If you ever had a Committee on Nominations who have done their whole duty, this year has been the time. There was a wide field for them to cast their eyes over and a large number from whom to make a selection of capable men to raise to the position of Third Vice-President and in their wisdom and judgment they saw fit, and wisely so, to make an entirely new departure, an election to the position of Vice-President being in direct line by promotion to the Presidency. Since our lamented and beloved friend, General Roome, occupied the position of first President of this Association to this time you have always had grey haired men in the Chair. Your Committee has seen fit to do otherwise, and as I said in my opinion, wisely. New members are coming in, and for several years they have been and still are largely young men. A majority, and I think quite a considerable majority, of our membership are comparatively young men. Perhaps some of the grey haired ones like myself (and most of the grey hairs have come to me within six weeks) will be very glad to be on the benches and to have young men at the helm. Your committee have very wisely presented, and you have approved, as your Third Vice-President the name of one who, since his connection with this Association, stands first and foremost in activity and energy in preparing valuable papers for the Association and doing work for it continually. I have the extreme pleasure of presenting to you Mr. Walton Clark. (Applause).

RESPONSE OF MR. CLARK.

Mr. Walton Clark—Mr. President, though they embarrass me almost out of the power of expression, I thank you for your kind words. Gentlemen, I cannot understand the indifference that is sometimes felt or assumed in the face of an expression of confidence such as you have given my unworthy self. An honor striven for, save by effort to be worthy of it, ceases to be an honor in the attainment; but when, by the unsolicited votes of his associates, a man is raised to the position of Vice-President in a body such as the American Gas Light Association, if he fails to feel, and to take every opportunity for expressing a deep sense of honor and gratitude, he is differently built from your Third Vice President elect. (Applause.)

President Harbison—The most difficult part of the duty of your Committee in preparing a list of names to be presented to you, was to select the name of some one who could occupy the position of your Secretary and Treasurer. As they looked back over the past years and saw how faithfully and thoroughly and completely that work had been done by Secretary Humphreys, the selection of a man to be his successor was not an easy thing—particularly as there are so many connected with the Association who are qualified to a greater or less degree to occupy the position. You have had in this chair a distinguished New Englander who has occupied the position of President, who has done himself credit and you credit as your presiding officer. He is a man be loved by us all and deservedly so. He will stay by you during the day, and if you are at all indisposed he will stay by you during the night. Indeed he would stick closer than a brother, if it were necessary. In the ordinary course of nature there was given unto him a son, and knowing to what attainments he had reached, and expected yet to reach, he wanted to send his own name to posterity, and so brother A. B. Slater, of Providence, R. I., my near neighbor, named this son after himself, and he grew up a chip of the old block, only more so; indeed you might say the old block with a chip added. (Applause.) Your Committee have unanimously selected that worthy son, who has within quite a recent time become a member of this Association, but during his membership we have learned to love and to esteem him—not simply because of the virtue, ability and qualifications of the father, but because of real merit and worth in himself. I have great pleasure in introducing to you brother A. B. Slater, Jr., as your Secretary and Treasurer elect. (Applause.)

RESPONSE OF MR. SLATER.

Mr. A. B. Slater, Jr.—Mr. President, and gentlemen of the Association. I sincerely thank you for the honor you have conferred upon me, and the confidence reposed in me, and hope that I shall not show that your confidence has been misplaced. After the execution of the duties of the office by so able a person as my predecessor, and especially after the execution of the duties of the office so faithfully and ably as at this meeting, I have great misgivings as to the outcome of your selection. But while I think that the duties of the Secretary are engrossing, still upon looking over the faces before me I am satisfied that the co-operation of the members will help the Secretary and will keep the duties of the office from becoming onerous ones. Our President referred to the older members as being relegated to the bench, but I think that we are not ready to have them thus disposed of. In fact some of them have not yet been admitted to the bar. (Applause.) The President has referred to my membership in the Association as being very short. It is very short indeed. I all the more appreciate the honor that is conferred upon me in consideration of the fact that my membership among you has been so short, and that you have put practically a youngster into the office. Those who have spoken before me headed by our notorious (laughter)—by our well-known brother White, are all men who have been selected for, and are expected to be, good speakers. But your Secretary is supposed to be a man of silence. Therefore, gentlemen, I can only thank you for the honor you have bestowed upon me. (Applause.)

President Harbison—You have in addition to what has been already reported elected the following named gentlemen as your Council:

Jos. B. Crockett, San Francisco, Cal.;
C. J. R. Humphreys, Lawrence, Mass.;
John Young, Allegheny, Pa.;
Irvin Butterworth, Columbus, Ohio,

for the term of two years.

Last year you elected, and their terms do not expire for one year yet: Messrs.

C. H. Nettleton, Birmingham, Ct.;
Jas. Somerville, Indianapolis, Ind.;
A. W. Littleton, Quincy, Ill.;
F. Egner, New York.

These gentlemen I declare members of the Council for two years and one year respectively. I believe that completes your elections.

THE PRESIDENT REPLIES TO ATTACKS ON THE COURSE OF THE COMMITTEE ON WORLD'S FAIR.

And now, brethren, before I close what I wish to say while I am still with you, I desire to refer to a matter that is not as pleasant as what has occurred up to this time. Some time ago it was proposed to hold what is known as the World's Fair, at some point in this country, to properly commemorate certain events in the history of the country. After a time, through various manipulations, it was decided that that Fair should be held in the city of Chicago. The gas industries of this country and of this continent, having grown enormously since the Centennial Exhibition in Philadelphia, it was thought wise by members of the various Associations that an organized effort should be made, that the gas industries should be fairly represented at the Fair. In furtherance of this object the New England Association (which is the parent Gas Association) named a committee to represent them in connection with similar committees to be appointed by the kindred Associations. At your meeting following the New England meeting, this Association appointed a committee to represent them on that general committee. The Western Association later on appointed a committee to represent them on the general committee. That was a year ago, last May. The Ohio Association did not hold an annual meeting until last March, and they at that time appointed an honored member of their Association to represent them on that general committee. So that, in the month of March of this present year, the four Associations had appointed their committes to represent them on a general committee in furtherance of this laudable object. Previous to this time, and after the meeting of the Western Association, I had the honor of being appointed Chairman of the general committee. No meeting of that general committee could be held earlier than the month of May. That meeting was held in the city of Louisville, during the time of the holding of the Western meeting. These committees were appointed by the four Associations with the express understanding that their personal time and services were to be gratuitously rendered; that they were not to be compensated for their labors individually in any respect; but that the actual expenses incurred by the committee should be borne pro rata by the various Associations. At that meeting of the General Committee in Louisville the whole subject was thoroughly talked over by the members present. It was not deemed advisable, because of the expense, to have all of the members of the committee visit Chicago to see the General World's Fair Committee as a first move, as it was thought that the expense would be too great, and we knew that the treasuries of none of the Associations were overflowing. So that the general

committee appointed an executive committee of three, from its own members, composed of the Chairman, the President-elect of this Association, Capt. White, and the Third Vice-President, Mr. Walton Clark, to represent the general committee to go to Chicago and interview the World's Fair Commissioners in behalf of the object we had in view. Previous to that time I had talked with the Hon. Leveritt Brainard, of Hartford, who is a Commissioner for the State of Connecticut to the World's Fair, and a personal friend, and he assured me that anything in his power that he could do he was ready to do in behalf of the object I had at heart. I had several conferences with him, and he wrote to the President of the World's Fair Commission, stating what our objects were in a crude way—we had not very clearly defined ideas of our own at that time—and in due course of time he received from the Secretary of Installation a letter outlining, so far as he could, what he understood to be the ideas of the World's Fair Commission. Immediately after the receipt of that letter Mr. Brainard decided to go across the water for a vacation. He handed me the letter from the Secretary of Installation, and asked me to follow the matter up as I might think best. I conferred with my associates of the sub-committee, and we decided that as soon as it could be arranged between us we would visit Chicago. My associates on this executive committee, Messrs. White and Clark, are, as you know, very active men, and it is not every day that they can leave their private business to go off for a number of days on the official business of this Association, or a number of Associations; and it so happened that when one could go the other would find it impossible to go, and vice versa. I had forgotten to state that soon after our return from Louisville in May, the Secretary of this Association (who was a member of that general committee) was laid on a bed of sickness, and we delayed week after week, hoping that we might have the benefit of his counsel and judgment before starting. After a while we reached the point where we found that Mr. Clark could not, for at least thirty days, go with us to Chicago; and he advised that, as the time for this meeting was drawing near, and whatever could be done ought to be done without any further delay, Capt. White and I go alone. And so Capt. White and myself arranged upon a time when we would start. We went to Chicago, and so far as we were able, as your representatives and as the representatives of the other Associations, we did our duty. We urged, with all the ability we had, the importance of the interests in which we were engaged, and the duty of the World's Fair Committee, to give us a fair show. Our opponents of the electric light industries are men of great wealth apparently, and are very liberal in spreading it around whenever they have an object to gain; and they had in a munificent manner volunteered to do considerable in Chicago by way of putting up a building of their own. They managed in some way to get the inside track in the lighting of the buildings, and so forth. As was suggested at our Association meeting, we had not a great deal of wealth available; and we did not see where we could raise the money—$100,000 more or less—to put up a building for the gas exhibits, and did not know to just what companies we could apply for money with success. I might say, in this connection, that I had from a distinguished gentleman, a member of this Association, his personal assurance of an earnest effort in our behalf for a very considerable portion of this money necessary; but getting the last $50,000 would be where the shoe would pinch; and so that kind offer has not yet been made available, because we had no definite plan that we could lay before the parties whom he represented. We visited Chicago, saw the Secretary of Installation, and laid before him our views, and he, in turn, gave us his, which, when simmered down, were to the effect that the Commission would provide for the gas industries a certain amount of space—and we mentioned to him what, in our opinion, would be a sufficient space for the exhibits that might be made by the representatives of those who were engaged in business in connection with our industry. He asked us to reduce our suggestions to writing, and he would present them to the Commission at their next meeting. He prepared such an application or communication in behalf of the gas industries, and as a committee representing the Associations, we subscribed our names to it. Then Capt. White presented that communication to Mr. Hurst, the Secretary of Installation, and since that time he has seen him again. Capt. White made a report to you yesterday of the doings of your Committee; and I am personally very much gratified to know that this Association heard the report, accepted it, and discharged your committee.

Now, brethren, this Association, in open session, appointed this committee of five members to represent them on the general committee. I hope that I am not wearying you with this matter, but I feel it is due to me and to you to know what my feelings are. You may have made a mistake, and probably you did, in naming the men that you did as your representatives on that general committee; but so far as we have been able we have done our duty. My ideas as to the duties of the committee are, first, to perform its duties, and then, second, to make report to the power that appointed it, and not to outside parties. The unpleasant feature of it to me is that a member of this Association, a man whom, as a man, I respect and admire, and I have been second to no member of the Association in extending to him the right hand of fellowship and greeting, in the Association and out of the Association, by name George W. Graeff, Jr., who is the Editor of a publication published in part in the interests of the gas industry in connection with other industries, has seen fit, as the editor of that paper, to malign, abuse, and ridicule, your committee for months past, week after week, week after week, over his own signature, and in thus doing to insult this Association who appointed them, in what I think is the most ungentlemanly and unprincipled manner in which I ever knew a member of any Association to be engaged. (Applause.) Now, brethren, excepting as your representative, I have not one iota of feeling in this matter. My record as a member of this Association, since its organization down to this day, I am not ashamed of, except it be because I have come so far short of doing my duty as a member; but I have done my duty to the best of my ability, and with all the strength that has been given me. While I have been a member of this Association you have known me, and have known of me as I have gone in and out amongst you. I have tried to conduct myself in such a way that I would not bring disgrace upon the gentlemen who had honored me by permitting me to become a member of their Association; and when you honored me with that appointment, as you have honored me by electing me to a position beyond which you cannot go—for no greater honor can fall to a gas man than to occupy the office which I now hold by your sufferance and kindness, as President of the American Gas Light Association—I say that the top round in the ladder has been reached, and I have, through your kindness and generosity, reached it from the ground—unfitted for it, unqualified for it as I am and have been, yet your generosity and kindness have brought me here. And when, as your representative, I tried to do my duty as I best could, to have been in this way abused, and continuously—if there had been but a single paragraph I would not have alluded to it—but week after week this thing has been kept up because we did not come home and at once communicate with the press, or with members of the Association, and because we did not week by week tell them what we were thinking about, or what we were trying to do, that paper took it for granted that we were doing nothing and abused us. After what has been said, as the Chairman of the Committee whom you appointed and to whom I would have been only too glad to be able to have made a report yesterday of the progress that we have been able to make in the matter, I present the matter to you to-day, with my own views on the whole subject. It is for this Association to take such action on the matter as they think is proper under the circumstances. (Applause.)

Mr. C. H. Nettleton—As it is now past the hour of adjournment, and as we meet again at two o'clock, would it not be well to adjourn now, and lay this matter over until our reassembly. I make that motion.

The Secretary—There are some notices to be read, if you will withdraw your motion for adjournment.

(Mr. Nettleton withdrew his motion, and the Secretary gave notice as to procuring tickets for the banquet, etc.)

Mr. A. C. Wood—The matter which has been alluded to by our President is a matter of very serious import. A severe and uncalled for criticism has been made upon this committee, and it has been followed up for weeks—

Mr. A. C. Humphreys—I move that we adjourn.

Mr. A. C. Wood—One word.

Mr. A. C. Humphreys—I will not withdraw my motion.

Mr. J. A. P. Crisfield—I second the motion.

Mr. A. C. Wood—If you will excuse me—I am not going to make any long speech about it, but this is a matter—

The Acting President—Brother Wood, the Chair will have to decide that, as a motion to adjourn is always in order, when we come together again immediately after recess, as a matter of courtesy Mr. Wood will then have the floor. The mover of the motion to adjourn declines to withdraw it, and the motion has been seconded.

Mr. A. C. Wood—If the mover will allow me a word, I will say that it is not my intention to talk upon the subject, but simply to make the motion that (calls for the question) that the matter be brought up immediately after lunch.

The Acting President—That will be the right of brother Wood, who had the floor when the motion to adjourn was made. Brother Wood has the floor the first thing after the Association comes to order.

President Harbison—It is now moved and seconded that the Association take a recess until half past two. And, brethren, as this is the last afternoon of your general meeting, and a good deal of business has to be done—much of it of importance—it is quite desirable that every member be in his seat promptly at half past two o'clock. Before I put the motion to adjourn, I want to say that by the strict orders of my physician, which I am living up to, I will not have the pleasure of meeting with you this afternoon; but I have permission from him, if I can rest well during the afternoon, to join you for half an hour at the banquet in the evening. I shall do the best I can to get that rest between now and near the time when you get through eating—I do not want to eat much, as I am on the starvation list—and I shall hope to see you in the evening.

The Association then took a recess until 2:30 P. M.

Second Day—Afternoon Session.

The Association met at 2:30 P. M., Acting President White in the Chair.

Various Matters.

The President—As your Committee has reported two answers received to the telegrams sent to our sick members, the Chair has now the pleasure of announcing that the following telegram has just been received from Secretary Humphreys:

"American Gas Light Association—Accept my hearty thanks for your kind message of sympathy and my best wishes for a pleasant and profitable meeting. C. J. R. HUMPHREYS."

PLACE OF NEXT MEETING.

The President—I believe the Committee on selecting the place for the next meeting, of which Mr. Scriver is Chairman, is ready to present their report.

Mr. J. S. Scriver—Your Committee report that we have received three invitations for the next meeting; from San Fancisco; from Montreal, and from Boston; and your Committee beg to report they recommend the city of Boston for the next place of meeting.

On motion of Mr. Egner the report of the Committee was received and the recommendation adopted.

COMMITTEE OF ARRANGEMENTS.

The President—I presume that some gentleman will make a motion with reference to the appointment of the usual Committee of Arrangements. The Chair will be pleased to entertain the motion and to name the Committee.

Mr. F. Egner—I move that the Chair appoint a Committee of Arrangements, consisting of five members, for the Boston meeting.

The President—If there is no objection the Chair will appoint such a committee during the course of the afternoon.

(The Chair subsequently named the following as the Committee of Arrangements for the Boston meeting: M. S. Greenough, Chas. D. Lamson, Fred. J. Davis, Dr. Robt. Amory and Robt. B. Taber.)

THE WORLD'S FAIR MATTER AGAIN.

The President—At the adjournment of the Association for its usual noontime, Mr. A. C. Wood who had the floor, and who was about to make a few remarks was under the ruling of the Chairman then presiding, entitled to the floor at this time if he desires it.

Mr. A. C. Wood—I have but very few words to say upon this matter. Until last evening I did not know of the publication of the articles referred to. My attention was then called to them, and the matter was stated to me as a fact. I did not at that time know that the matter was so serious, and of so much moment as has been described or told to us by President Harbison. I feel that it is a matter that cannot be passed lightly over. That it is a matter that really and fairly deserves the censure and an expression of the disapprobation of this Association. The freedom of the press is, of course, a very desirable thing, but that freedom is frequently and often abused, and in this case most seriously so. A man who becomes the editor of a petty paper feels at once duly licensed to lay himself out to abuse everybody and anybody that he sees fit. For an active member of this Association—as he did—to print such articles as have been referred to by President Harbinson, censuring a committee duly appointed by this Association, is an act certainly deserving of censure. I am not prepared at this moment to make a motion, or to offer a resolution in carrying out my ideas of what this censure should be, and so I will leave the matter for further discussion, and for the expression of opinion among the members of the Association.

Mr. W. P. Fodell—When Mr. Harbison was speaking this morning I thought the same as Mr. Wood does—that it was due to the Association to put on record something that would show its confidence in our President. I have drafted a little resolution—probably it is not strong enough for Mr. Wood to second it—but I offer it, not in anger, but more in sorrow, and merely as a matter which I think is due to this Association. It is this:

"WHEREAS, the Editor of [here is given the name of a paper printed in Philadelphia] a member of this Association, has published, without cause, unjust articles in said paper reflecting upon the conduct of the committee appointed for securing space at the World's Fair, to be held at Chicago. Therefore, be it

"RESOLVED, that the said publications were entirely without foundation, unwarranted and unjust; and that the Association in accepting the report of said committee, and discharging them, do so fully satisfied that every exertion was made by said committee to secure the object of their appointment, and to carry out the wishes of this Association."

The President—You have heard the resolution offered by Mr. Fodell. Is that resolution seconded?

Mr. J. W. Newell—I second it.

The President—The resolution which has been read to you, and seconded, upon this subject, seems to me to be in good temper and in a fair spirit, as it is simply a vote sustaining your own committee in its report, and expressing your satisfaction with it. It seems to me to be a very happy way out of what might be an unpleasant matter here. There is undoubtedly good ground for the feeling that was expressed by Mr. Harbison. However, our President has been a very sick man, and during the long hours of his sickness he has thought over this matter, and has attached possibly more significance to it, much more I know, than have the other members of his committee. I think this is probably as pleasant a way as we can get out of this matter, and drop it at once. We have no time for angry discussions, and have no stomach for them. (Applause.) I have no doubt we all know that Mr. Graeff has been received and esteemed by us as a gentleman, and as a witty one withal; and I think that sometimes, like myself, his inclination to be funny runs away with his better judgment. I think the passage of this resolution will be all that will be necessary. The Chair presents it for your consideration, and trusts that there will be no discussion of this subject.

Mr. G. B. Neal—I ask to have the resolution again read.

Mr. W. R. Addicks—I merely want to say—and I do not know how many more there may be like me in the Association—that for myself I have not seen the articles referred to, and, therefore, cannot vote in any way on them in any case. There may be others of the Association who are placed in the same position. I was going to move, therefore, that any further discussion of the question be postponed, that the matter be referred to the Council, and that we do not take up the time of the Association with it now.

The President—That would be a very proper motion, but I think if the Secretary will read the resolution which has been offered, for the instruction of the gentlemen who did not hear it, you may feel that the resolution is itself a sufficient wind-up to this matter. If not, it can be referred, as you suggest, to the Council; that is the best place for it. Certainly not here.

Mr. A. G. Glasgow—If the motion made has not been seconded, I would like to second it.

The President—In the meantime we will have the resolution read, as previously asked for by Mr. Neal.

(The resolution offered by Mr. Fodell was read by the Secretary.)

Mr. C. A. Bennett—I would suggest as an amendment to that resolution that the name [here Mr. Bennett again named the Philadelphia paper] be eliminated, and that there be inserted in its place the words "a certain periodical."

Mr. Fodell—I will accept the amendment.

The President—The amendment is accepted, and becomes part of the original resolution. The question is on the adoption of the resolution.

Mr. A. C. Humphreys—I rise to a point of order. I think that Mr. Addicks' motion, to refer, has precedence.

The President—The Chair would not so rule.

Mr. A. C. Wood—I hope that the motion with the amendment will not prevail. I think that the resolution as written, and as it stands, is all-sufficient, and all that would be required. I trust that the amendment will not prevail.

Mr. F. Egner—I move the previous question.

The President—The previous question is called for. All in favor of the adoption of the resolution as read by the Secretary will say "aye."

Mr. A. C. Humphreys—I ask for the call of the roll.

The President—It is a very unnecessary waste of time.

Mr. A. C. Humphreys—Very well. I call for the roll.

Mr. C. A. Bennett—I think the question ought to be amended. The amendment to the resolution as first offered was accepted by the mover.

Mr. A. C. Humphreys—I call for the roll.

Mr. A. C. Wood—Will the gentlemen of the Association understand that by voting in favor of the passage of the resolution it carries the amendment with it?

The President—The calling of the roll has been asked for. It is the right of any member to ask for the calling of the roll, although it will take a good deal of our time.

Mr. C. H. Nettleton—May I suggest to Mr. Humphreys that a standing vote will accomplish the same object as a call of the roll.

Mr. A. C. Humphreys—Yes; if the names are recorded.

Mr. W. R. Addicks—Is the vote on accepting the amendment offered?

The President—Do you mean your amendment to refer it to the Council?

Mr. W. R. Addicks—Yes.

The President—I thought you referred to the amendment of Mr. Bennett, which Mr. Fodell accepted. That was the subject upon which I was ruling. The Chair is in error from the fact that he did not recall that amendment at the moment, and in ruling, as Mr. Glasgow had seconded the motion to refer to the Council, that, as an amendment, would have precedence; and the Chair apologizes for its own errors. I did note, but forgot, that Mr. Glasgow had seconded your motion. Therefore, my ruling was made upon the subject of Mr. Bennett's proposed amendment. The question is now before you.

Mr. A. C. Humphreys—I would not have made my request for calling the roll if the Chair had ruled otherwise.

The President—The Chair ruled carelessly, and apologizes to the House for it. His intention was to rule upon the question, supposing that the other amendment had not been seconded. The question now before the convention is on the amendment offered by Mr. Addicks—that the whole matter be referred to the Council. That amendment has been seconded, and it is now before you for consideration. Do you, gentlemen, desire to discuss the matter before voting upon it? It is open for discussion. There seems to be no desire to discuss the matter. All in favor of a reference of this resolution, and of the whole matter, to the Council, will say "aye;" the contrary, "nay." It seems to be carried. The Chair decides that it is carried. The matter will be referred to the Council.

DISCUSSING THE PAPER BY MR. DOUGLAS.

The President—On receiving Mr. Harbison this morning we just closed the reading of a very interesting paper by Mr. Douglas, the discussion of which was interrupted by the entrance of President Harbison. Mr. Douglas is now with us, and will kindly come to the platform and be prepared to complete his remarks, if not already completed, and to answer any questions which any gentleman may desire to ask him.

Mr. D. Douglas—I have almost forgotten what I had been intending to say further on the subject; but I have some samples here of various things which I would be glad to have any gentle-

man later on examine. There are some little matters here which I think might be of interest, especially to those who are more particulary interested in chemistry. If there are any questions connected with this subject that I can answer I shall be glad to do so.

Mr. A. S. Miller—Can you tell me the temperature of your separating tank, where the tar and water are originally supposed to be separated, running from the scrubbers and wash-boxes?

Mr. D. Douglas—I am not able to tell you the exact temperature of the water that flows from the box, but it is pretty hot; it is pretty well toward the boiling point. You cannot keep your hand on it; I think it is about 200°. I did not look at the thermometer.

Mr. A. S. Miller—Concerning the asphalt I would like to ask if you used it for paths only, or for road beds as well.

Mr. D. Douglas—I only use it for paths. As I explained in the paper, we did not have enough material to make asphalt for roadways. I proposed to find enough for the sidewalks, but I did not have enough even for a sufficient business in that direction.

Mr. A. S. Miller—How long have they been in use?

Mr. D. Douglas—Those I refer to have been in use for a year and a-half, or two years, and are perfectly good. They are laid in streets where we have a good deal of travel.

Mr. W. H. Pearson—The question of the disposition of tar is one that every water gas man who is using any heavy oil is very much interested in. At our works we have been through all the difficulties that Mr. Douglas states he went through, in order to eliminate the water which is held mechanically (not chemically) in the tar. I will ask our Superintendent, after I have got through with what I have to say, to describe the process adopted by the parties to whom we have disposed of our petroleum gas tar, as he has witnessed the operations, whereas I, for various reasons, have not been able to do so. Am I right in understanding Mr. Douglas to say that with the smaller of the two superheaters he got about one-fourth of the tar and of the amount of oil used?

Mr. D. Douglas—No, sir; I said we found in the tar tank about one-fourth of the quantity of oil used *apparently* as tar. Later investigation showed that a very large proportion of that tar was water; and, finally, I think left about six-tenths of a gallon to one thousand feet—that was tar, without water.

Mr. W. H. Pearson—I thought that that was due to your using another superheater.

Mr. D. Douglas—No. Perhaps I did not make myself clear as to that. We were dipping our tar tank in the ordinary way, and supposed that what was giving the color on the dipping rod was tar; and it showed us 1 1 4 gallon of tar made from 1000 feet of gas, which struck me as being altogether unwarranted. Later on, by eliminating the water, we showed only 0.6 of a gallon of actual tar in the tar well per 1000 feet of gas. Our present working gives us one-third of a gallon of tar per 1000 feet of gas made. I put in 4 1-2 gallons of oil, and I get back one-third of a gallon of tar.

Mr. W. H. Pearson—As to what tar we are getting now, while using the U. G. I. Co's. improved Lowe process, I cannot speak with accuracy, but should say about one-tenth of the quantity of oil used. I may say that we are getting about one-seventh, when operating the original Lowe process without the carbureter. Did I understand Mr. Douglas to say that by mixing the tar from the water gas plant, where both coal gas and water gas were manufactured, with the coal gas tar, the water was distributed through the whole, and that no difficulty arose except that the tar was a little thinner?

Mr. D. Douglas—I think I stated in adding the water gas tar to a larger quantity of coal gas tar, the coal gas tar absorbed a good deal of the water gas tar and liberated the water; consequently, distillation was possible, as the water did not give any more trouble. That was not done in my works.

Mr. W. H. Pearson—Is the gentleman here at whose works that was done?

Mr. D. Douglas—I have made a good many inquries from gentlemen who are using both processes. I made an experiment myself with the coal tar, and proved that that was the case, in my own office, but not in my works. I am perfectly well satisfied that it works so in my office; and other gentlemen using it tell me that with them it works in the same way.

Mr. W. H. Pearson—Parties in Toronto have accomplished, I think, pretty thoroughly what you have nearly accomplished with your apparatus, and I think in a simpler manner; but I prefer to leave the explanation of that to our Superintendent, as he can give it more accurately than I can, for I have not personally seen the process in operation.

Mr. F. Egner—The paper read by Mr. Douglas I consider to be one of the most valuable and practical papers which we have had before the Association in some years.

Mr. W. H. Pearson—I think a little additional light can be thrown on the subject, if our Superintendent can get over his native modesty and state what he knows about it. I think he can tell something which will be interesting to every water gas man here.

The President—We shall be glad to hear from Mr. Pearson, Jr.

Mr. W. H. Pearson, Jr.—The mode of operating the process is as follows: Three tanks, at different elevations, are used for the purpose, so that the tar can run by gravity, from one into the other. The tar is first pumped into the upper tank, which is open on the top, and is there heated by the introduction of live steam, by which means a portion of the water is removed by evaporation. The tar is then run into a second tank, which is entirely covered, but with an outlet pipe to the atmosphere. The tar is then further heated, by means of superheated air, and the water passes off through the outlet pipe, in the form of vapor. The tar is then run into a cooling tank, and is ready for barrelling. In the upper tank live steam is introduced through a pipe which runs to near the bottom of the tank. The air is introduced into the second tank at a pressure of about 30 pounds. It is first pumped into an accumulator, and is then passed through a furnace by which it is heated, and is forced from thence, directly into the tank. Most of the water is taken out in this way, and no trouble is experienced with it after that.

Mr. A. S. Miller—I think the paper of Mr. Douglas leaves the Association under the impression that most of the water gas tar has 50 per cent. of water in it. I have never made any personal analysis of this tar, but, in getting bids for it, I had occasion to send some to the distillers, and it is not to be supposed that distillers, in buying tar, would give any low percentage of water if they could help it. They reported that we had only 20 per cent. of water in the tar. They buy the tar from us, and pay us a price almost as great as coal tar is selling for in the immediate neighborhood. We can retail that, for any work for which coal tar is used, for just about the same price that coal tar is retailed at. There is not a difference of 50 cents per barrel.

Mr. J. A. P. Crisfield—I would like to ask Mr. Pearson whether, in the process he describes, the steam comes in contact with the tar?

Mr. W. H. Pearson, Jr.—The steam comes in contact with the tar right at the bottom of the tank. The tar is first prepared in the open tank, and then is run into the closed tank, where the superheated air is introduced.

Mr. J. A. P. Crisfield—How are the second tanks heated?

Mr. W. H. Pearson, Jr.—With hot air.

Mr. J. A. P. Crisfield—How is the air heated?

Mr. W. H. Pearson, Jr.—By pumping it through the furnace in a series of pipes running backward and forward.

Mr. C. R. Faben, Jr.—I think the percentage of water contained in gas tar varies with the form of apparatus used. In the washer—or rather the scrubber—we have used, the arrangement is such that the water, falling a great distance, makes an emulsion with the tar, and the percentage of water contained is very high: 50 per cent. would not cover it. It would be nearer 66 per cent. I have prepared that tar for use as fuel in furnaces, and had to get rid of the water, and I very successfully accomplished it by resorting to the use of a still known as the "Yaryan" still, which consists of a boiler tube 2½ inches in diameter, encased in a 3-inch tube. The annular space between the two pipes is charged with steam by the ordinary boiler pressure, and a continuous stream of tar is let into the upper portion of this pipe, and flows through this still to the outlet. In passing through there all that portion of the tar consisting of water, and of other products that will volatilize at the temperature of steam, rises in vapor, and that portion of it which is not volatilized comes out as clear tar, with all the water eliminated. The still that we used has four lengths, of about 16 feet each, and they are connected together at the elbows so that they make about 65 or 70 feet of 2-inch pipe to travel through and give the water an opportunity to rise in the form of steam.

Mr. A. E. Forstall—I would like to ask Mr. Douglas or Mr. Pearson how long it takes to get the water out of the tar by the Douglas process, or by the Toronto process.

Mr. D. Douglas—I would just point out that, after all, the whole subject is a question of manipulation. It is very evident that it requires more heat than 212°, but if you get the temperature up high enough the water will ultimately settle. As to the question of doing it cheaply and comfortably and well, Mr. Pearson's method was rather too expensive, too elaborate, for me to try in a place like Savannah, and would be rather too big a job. The other method, of doing it by steam jacket, I think is done at more cost, as it would naturally cost more money to get your heat applied to the tar by first putting fuel under a steam boiler. I was trying to do it in a simple way, and for a moderate sized works. In this particular instance I merely took a shell, and put a fire under it, and in that little boiler there the whole thing is done. I do not have any elaborate arrangement, but it can be done in any form of apparatus, if you can get the temperature. With regard to the quantity of water in the tar, I may say that it will vary very much. If you use a large quantity of oil, and make a large quantity of oily tar, I have no doubt there will be less water than if you are making a thicker tar, and with thicker tar water will be harder to separate. All these things are matters of condition, and every different gas works, I have no doubt, would present a different condition.

Mr. C. R. Faben, Jr.—I have to offer an excuse for my remarks. I was speaking at a disadvantage. I had not the pleasure of hearing the paper of Mr. Douglas read this morning; and as the discussion led to a method, I thought that I would describe the method which I used. I would like to ask Mr. Douglas about his process. Whether, on applying heat to a body of tar containing water, it does not foam a great deal.

Mr. D. Douglas—That is exactly the principle I used. The idea I had in doing this was that every little globule of water is encysted in tar, and when you apply heat that forms a bubble, and a mass of these bubbles is foam. I thought if I could only get these bubbles hot enough they would burst, the steam would come out, and the tar be separated. (Referring to the diagram). I put the tar in this still; it is forced in by this pipe; we put tar in below *here*, and then wait until the pressure goes up to 25 pounds on the pressure

gauge, when we open this cock, and then the still is full of foam. The foam comes up this pipe, is carried along here, and here, at the outlet I put a wire screen for the purpose of making the bubbles burst in passing through that screen. They then fall upon a plate here, and the tar drops into the tank, and then I find the whole thing separated. I expected that the whole of the tar would come over in the form of foam, but I find that a great deal of the tar is actually separated in this still itself, and a certain quantity of it is being drawn off *here* in the shape of heated water and tar. That is the whole process. It is adapted to small works which cannot afford to devote $1000 or so for experiments.

Mr. W. R. Addicks—Is there any odor to those bubbles of air?

Mr. D. Douglas—Undoubtedly a little odor from the gaseous and lighter oils comes off; but you will understand that as I would have the whole thing boxed down, all of the vapors would be condensed, and would not annoy me at all.

Mr. A. E. Forstall—The object of my question was to see if there were no means of making any different arrangement with the water gas tar than with the coal gas tar, and whether it was entirely a question of expense. In Chicago they treated it in exactly the same way as coal tar. I want to see if there is any saving in fuel in these other methods, by putting steam through first, and then superheating afterward.

Mr. A. B. Slater, Jr.—I have had some experience with water gas tar at Providence, and in the way we ran we had no water in our tar at all. We started, first, of course, with the tank full of tar—it is an underground storage tank—and then instead of running water into the seal we used a steam pump, pumped that tar into the seal, and kept our seal filled with tar. We found no appreciable variation in candle power by doing that, and all the condensation we had from the tar went off into the storage tank and accumulated there. No water came in contact with that tar. This was with a Lowe double superheater plant. Ordinarily the water goes into the scrubber and passes down through into the seal. We use no water at all with the scrubbers. We found that we got along just as well as we did when we used water, with one exception, which exception was that when the water went through the scrubber it acted virtually as a jet condenser to relieve the condenser of so much work, so that when we used no water there the condenser had more work to do in reducing the temperature. By that means we got our tar pure and clear without any water at all, and by no other process than the storage tar tank and the steam pump—that doing the whole business for us.

Mr. W. R. Addicks—Did you have any water in the scrubber?

Mr. A. B. Slater, Jr.—No water whatever.

Mr. W. R. Addicks—I am not using it there because I did not want any more water to contend with in separating the tar. I thought all along that the principal source of trouble with water in water gas tar is from the water in the hydraulic main. I think Mr. Slater hits the nail on the head in not using water in the seal. As far as the scrubber is concerned, the condensers will take care of themselves, and you will find very little water in water gas tar except that which is obtained principally from the hydraulic main.

Mr. A. B. Slater, Jr.—Another point I had in view in doing away with water in the scrubbers was to have the gas come in contact with no water whatever until after the gas has been reduced to the normal temperature—believing that a good deal of condensation of aqueous vapors in gas induces the formation of naphthaline. I had some trouble with naphthaline before beginning to run the tar that way, but since then have had no trouble from naphthaline in any place that I am aware of. In the wooden trays that we use in the scrubbers, and which have been running for a long time, with no water in there, we found the wood to be practically in the same state as railroad ties which have been creosoted, in practically the same condition.

Mr. W. H. Pearson—How many scrubbers have you?

Mr. A. B. Slater, Jr.—We have one scrubber on each set, and each set has a capacity of 20,000 feet per hour.

Mr. C. R. Faben, Jr.—What do you use in the seal before the scrubber?

Mr. A. B. Slater, Jr.—I use tar for that. I have a small steam pump to pump from the under-ground storage tank.

Mr. C. R. Faben, Jr.—How long have you followed that practice, and what do you find to be deposited there?

Mr. A. B. Slater, Jr.—Since the first of last May, and I have had no deposit there at all, except in one case, where the man operating the plant allowed his heats to get too high, and formed some carbon, some of which came down into the seal from the stand pipe into the hydraulic main, and there was a small collection of fixed carbon there, but not enough to amount to anything.

Mr. C. R. Faben, Jr.—You draw the tar back from the scrubber?

Mr. A. B. Slater, Jr.—That goes out in the drip by itself.

Mr. W. H. Pearson, Jr.—Does Mr. Slater pump his tar through the scrubber into the wash box?

Mr. A. B. Slater, Jr.—The tar goes directly from the pump into the box, and nothing goes through the scrubber except the gas.

The thanks of the Association were voted to Mr. Douglas for his paper.

Mr. A. B. Slater, Jr., of Providence, R. I., then read his paper on the

INTENSITY OF LIGHT.

The title of this paper is slightly a misnomer owing to the peculiar and forced circumstances of its generation. The very unsaturated request of our Secretary pro tem. for a paper was heard and title given; but, then, in comparative vacuity of time it became necessary for the writer to clothe his ignorance in such words as might possibly disguise it, hoping that the thoughts herein suggested (none of them new or original) might draw out such discussion as would help some of us in making practical application of the principles sought.

You all understand the wave theory, which is the basis of nearly all present operations in light, that our commercial as well as the natural light is compounded of different colored lights of different wave lengths and corresponding frequency of vibrations.

The number of vibrations in a given time determines the color of the light, but the amplitude or scope of the vibrations determine the degree or intensity.

One prime object for the gas lighting engineer is to secure the production of the greatest amount of illumination for the money expended. The lights may be large or small, intense or weak, and of any desired color. These different properties may be independently changed in the same light, producing a range in variety adaptable to all requirements, if it is correctly understood what the conditions of the case need.

There is no commercially produced light which is not concomitant with and practically dependent upon heat for its generation. In fact light and heat both follow the same, or so similar laws as to be considered merely different manifestations of the same form of energy. The heat which brings about the incandescence may be mechanical, chemical or electrical. Mechanical as by friction, presumably as in the case of meteors, electrical, as we are all familiar with in the different electric lights, and chemical either directly by combustion of the incandescing body, or indirectly as when the incandescent body receives its heat from another source.

The ordinary observer knows that when a body is heated, it first begins to glow with a deep red which, as the temperature rises, passes up through vermilion, yellow, white and finally to a bluish white. If we analyze this light in its different stages, we find that the various changes are very interesting and a knowledge of them valuable for practical application. We find that the light, at first a dark red, gradually adds to itself the colors of the continuous spectrum in their regular order, from the least to the most refrangible, from the red with its long wave length to the violet, with its minute wave length, and 800,000,000,000,000 of vibrations per second.

Nearly all solids on incandescing follow this same order whether their heat is derived from their own combustion or from some other source—the same degree of heat yielding the same extent of color, so that the temperature of an incandescent solid may be determined if within certain limits (from 1000° to 2200° F.) by spectrum analysis of the light emitted. Incandescence begins at about 980°, but is first perceived ordinarily at about 1000°.

We know that the range of sensibility of the ear to sound is very limited, many sounds which we know to occur being beyond the capability of the ear to perceive, and also a sound of constant pitch may be so soft as to be imperceptible, or it may be so intense as to be painful, and intense, high sounds are the most painful and dangerous. We have the parallel of this in light, for our visible light or color disappears in darkness beyond the violet, and our eyes show us nothing below the red although we know the rays are there. And, too, we may have a color so faint as to be invisible or so intense as to be very painful, the more so as it approaches the high or violet end of the spectrum. There is no doubt of the effect on the eye, of a powerful naked arc light in which the violet and blue rays assert their prominence.

In the analysis of light, as before referred to, it is also found by special comparison that not only are the different colors added by the rising temperature, beginning with the red at about 1,000°, and finally reaching the violet at about 2,100°, but that their intensity increases after their appearance, and that, too, much more rapidly than the temperature. Platinum, for instance, yielding, at 2,600°, almost 40 times as much light as at 1,900°; and we note also that the increase of effect produced on the eye by the rise in intensity of the various colors is much greater in the case of the more refrangible rays than in that of the less refrangible red rays. Thus a gas light at 2,200° emits all of the colors given by the arc light at 8,700°, but the latter has the rays toward the violet end of the spectrum much more intensified than the lower rays toward the red; the difference in intensity of the two lights being due to the difference of 6,500° temperature.

With different colors of comparatively equal intensity the yellow is most visible; hence it is that, with two lights of equal size and density, the eye will pronounce in favor of a yellowish in preference to a bluish light for illumination. But what is illumination? Let us examine an ordinary gas flame first and work to a definition.

For combustion we take air for its oxygen, and will first mix it to excess with the gas, which we find will not then burn. But we will reduce the amount of air and after reaching a point at which combustion can take place, we very soon arrive at a saturated or explosive mixture. At this point combustion is instantaneous and no light is emitted, this being the form of combustion used in gas engines. Passing this point in reducing the amount of air mixed with the gas, it becomes necessary for complete combustion to give air at the point of ignition, and we arrive at the conditions of the Bunsen burner, but still get but little light, and that due mostly to the carbonic oxide. If we now use the Bunsen burner and gradually cut off the air supply at the base, we notice this:

that when the air supply is too great, or what is equivalent, the gas supply too small, the flame will, as we say, retreat, as the mixture approaches the explosive proportion, and in most cases will then have insufficient air supply causing incomplete combustion; one noticeable result of which is the liberating of hydrogen from the marsh gas, forming acetylene, which, escaping unburned, is readily detected by its odor. Still reducing the air supply, a dark cone rises in the center, the surface of this cone showing us where the mixed air and gas arrive at the degree of ignition. This cone will rise gradually, at the same time losing its sharp definition and finally becomes undiscernible.

Under the conditions of combustion so far, our gas, if good, containing only hydrogen, carbon and oxygen, has yielded us no light, because the hydrogen and carbonic oxide in burning are practically non-luminous, and the gas has had the air so mixed with it that the carbon was oxidized as it became nascent without being brought to incandescence. Proceeding with the experiment, the air mixed becomes insufficient for complete combustion and the oxygen, having greatest affinity for hydrogen, collects it from the various gases in the mixture, but is insufficient then to oxydize all the remaining carbon, some of which thus set free is made incandescent by the heat as the current takes it up to where it finds oxygen to combine with.

The flame draws air in upon itself and its outer surface shows the same effect as the inner part, but with the addition that the supply of oxygen is greater and by its diffusion the flame finally supplies to the inner part, as it rises, the necessary oxygen to complete combustion. If we take a horizontal section of this flame, we will have a ring of light which will show yellow, in the middle of its width, but the colors to the inner and outer edges both run to the violet end of the spectrum, showing not a trace of the red and orange; these colors giving a direct index of the temperature at the different points on the diameter of the flame. Still reducing the air supply, the yellow in the section gradually broadens on its inner edge and shows a gradual transition to the red end of the spectrum, which is reached when the air opening is entirely closed.

The gas now depends entirely on the air surrounding and diffusing into the flame. The hydrogen and carbonic oxide oxydize directly, furnishing heat to decompose the hydrocarbons in proportion to their carbon, most of which, set free, rises in the flame becoming incandescent, and if the diffusion of air into the flame be insufficient, due perhaps to low pressure on the gas at point of issuing from the burner, the carbon will agglomerate and, its temperature falling below the point of ignition of solid carbon, it passes off as smoke, perhaps being deposited as lampblack. In fact a very large percentage of the carbon in the gas may thus be deposited by giving insufficient air and also chilling the flame.

If now we increase the pressure of the gas, its increased velocity on issuing from the burner causes it, like any jet, to draw in upon itself the surrounding medium, and the result is an excess of air, first mixing into the flame, making complete combustion with part of the gases and breaking up a portion, combining with some resultants and setting free others which escape and the gas is not all burned. Carrying this still farther, the excess of air exerts such a cooling action that the flame will finally in actual fact blow itself out.

Now let us return to the conditions of good combustion for luminosity, using a flat flame burner to get a flame of larger area. Now we can see that the *intensity* of the light depends upon the degree of incandescence of the minute particles of free carbon rising in the flame, and that is governed by the heat generated, less that absorbed by diluents and excess of air, and also, in case of a bad burner, by the burner itself. The intensity then being in direct ratio to the temperature.

The *density* of the light is equal to the intensity of the light multiplied by the amount of surface of luminous carbon per unit of area; and the *quantity* of light from any source is equal to the density multiplied by the area of the luminous source as a whole. Hence we see that we have two lights of the same size and intensity, but of different density and consequent illuminating power; the density being the measure of the quantity and the intensity the measure of quality of the light emitted. This can be proved on the bar photometer by varying the composition of the gas tested. Now we may say that the *illumination* of an object is the amount of light received by it, less that absorbed and directly transmitted.

From the foregoing we see that the richer the gas the smaller the burner orifice must of course be, or the pressure greater, thereby drawing in the necessary increase of oxygen, which, within limits, will intensify and thus reduce the space of combustion and so make the light more dense and intense. The luminous flame grows comparatively less in area. Increased pressure will not cause the amount of air drawn in to increase in the same proportion as the amount of gas increases, the amount of gas issuing being directly as the square root of the pressure and inversely as the square root of its gravity.

Considering the definition of density of light, we find the reason that, in testing gases of different candle power with a flat-flame burner, the light from the poorer gases suffers less by taking the flame edgeways than that from the richer gases.

Sugg said (if I quote him correctly) that "with like burners, equal sized flames are of the same candle power," and hence originated Sugg's Illuminating Power Meter. But, laying aside the question of gravity, have we not found that by varying the composition of the gas we may vary the density of the light from the same size flame and thereby its candle power? So that if Sugg's meter is to be commercially correct, the composition of the gas must be kept within certain lines; that is, it will do for only the particular kind of gas for which it is adjusted.

In photometry instead of saying that the *intensity* of the light is inversely as the square of the distance, we may say that the *quantity* of light is in that ratio; for we admit that the quantity of light from two candles is greater than that from one, but is there really any greater intensity?

There are really only two photometers that are commercially practical for testing gases of various kinds—that of Bouguer, derived from Count Rumford's (the only one in which lights of various intensities of distinct colors may be accurately compared,) and the bar photometer in its many forms and with its various accessories as the refrigerator, air oven, reducing lens, etc. With any photometer we must have a standard of light and we find quite a list of candidates, beginning with the candle, which, when properly made, still stands to the front for practical use, the Carcel, Keates and Pentane Lamps, the Platinum Strip and various other ingenious devices, coming finally to the Methven Slit.

Most of these require more time and care in their use than their advantages are worth. The Methven Slit, however, is a very clever and practical device; for, as the same size of slit is used for gases varying within wide limits, we find that within those limits the gravity and composition of the gas, as regards heating components, will not vary very materially, hence the intensity of the light is within narrow bounds, and as the burner used for it is an argand, it virtually presents to the slit one flame behind another, thus maintaining the effect of one flame of practically uniform density of light, so that the quantity of light which passes the slit is very constant when used with gas which is within the limits for which it is adjusted. One very great advantage of this form of standard is that, the same gas being used at both ends of the bar, the colors of the lights will be about the same except only with the extreme variations in the burners.

It is obvious that no one burner will give fair results in testing the candle power of all commercial illuminating gases. The chemical composition and specific gravity must both be respected; and knowing these, burners can be constructed, simple and cheap, to suit the requirements of any particular case.

Our photometers measure not simply the intensity, but the quantity of light from a given source, and although we may have the same quantity of light from a small source of high intensity as from a large source of low intensity, the illumination from them will be of totally different character. Extreme variations in the distribution of light on the retina strain and injure the eye. Everybody knows the effect of looking at a bright spot on comparatively dark ground, or a very dark spot on a bright ground. The effect is very much lessened if there be no sharp outlines, for then the contrast is reduced, and it is found that for this reason the penumbra afforded by large lights count much in their favor.

This brings us to the diffusion of light, which is simply direct light reflected, refracted and diffracted, suffering partial separation and recomposition, thus being toned by the color of the objects by which the diffusion is accomplished. While penumbra are produced by the difference in angle of direct light from different parts of the same source, diffused light is not limited to such definite angle, and, therefore, blends the shadow, often to a mere shade. The diffusion of the light will be greater as the source is larger, depending also upon the density of the light, and in proportion as it contains the more refrangible colors.

It has been stated that white light would not diffuse as well as yellow light, but as white light has all the components of the yellow light there can be no greater diffusion by the latter, except that it be greater in quantity, noting also that yellow is the color which, of all the colors, taking them singly, produces the greatest sense of illumination in the eye.

Heretofore, among gas makers it has been considered that the question of illumination was a very complex one, that intensity and candle power were the same thing, and that color was entirely independent of intensity, while density of light, although barely noticed, simply as a rich or thin light has not been recognized. In gas lighting, the light being emitted by individual particles of carbon, the density of the light must be considered as distinguished from intensity.

By this we see why compounding argands, as in the six-ring Douglas lighthouse burner, the efficiency of poor gases is enhanced so much more rapidly than that of rich gases; for the poorer the gas the fewer incandescing particles of carbon per unit of area, thus leaving space for the inner flame to send its light through, and add to that of the outer flame. With a rich gas there will be less opening through the outer flame, and the light of the inner flame would be proportionately obstructed, while both gases receive the benefit of the concentration of heat.

With incandescing burners many of the conditions are inverted, for now the gas is burned only for the greatest amount of heat that can be derived from it, and we find a new subject for investigation. I have already stated that nearly all solids follow the same order in emitting light when heated. But many solids do not, some becoming luminous in a ratio far differing from that observed in elementary solids, and notably among the metallic oxides, whose qualities have been described by Mackean, while the subject of super-incandescence, or luminescence, is thrown open by the paper of Mr. Nichols to the New York Electric Club.

Discussion.

The President—You have heard an interesting and instructive paper on a topic of interest to us all. I trust you have given it a careful listening, and are prepared to discuss it, or at least to question the writer for the reasons of his views.

Mr. C. R. Collins—Did I understand Mr. Slater to say that the only luminosity was due to the carbonic oxide?

Mr. A. B. Slater, Jr.—Under the conditions of combustion which I was then describing the only illumination shown at that point would be due mostly to carbonic oxide. There might be a trifle due to the methane, but I think not much, if any.

Mr. J. A. P. Crisfield—I would like to ask Mr. Slater what is the best kind of burner for 28 candle power water gas?

M. A. B. Slater, Jr.—There could be quite a variety of burners constructed which would be very good for it. It would be hard to determine that without experiment. I should think that a burner which would give a very thin flame, and that would give full scope to the heating components would be the best.

Mr. J. A. P. Crisfield—Is the argand burner a good burner for water gas?

Mr. A. B. Slater, Jr.—It depends entirely upon the construction, I think. I should not consider it as good as a thin flame—a flat-flame burner. In fact I have found by my own experiments that the same gas, (high candle power water gas) has given better candle power in the bar photometer with a thin flame, flat-flame burner, than I got with the ordinary D-argand.

Mr. A. E. Boardman—I have listened very attentively, and with very great pleasure to this paper, and to the others this morning which throw light on the intensity of flame, flame temperatures, and the effect of temperature of incandescent carbon on flame, with regard to luminosity. I am glad to see that Mr. Slater's paper points toward the position which I think I have always maintained—that large flame areas, even if of a little less intensity were better for general illumination in increasing the penumbra of the direct light, and increasing the ability of the reflected light to produce the sensation of light upon the human eye. I think that this explains in a manner the reason why, although the mixture of water gas and coal gas in the direct experiment, by photometric examinations and by the theoretical calculation of flame temperatures, etc., does not indicate that it gives or would give a higher illuminating power; still to the eye it does. It increases the flame area of the water gas, and increases the flame temperature of the coal gas, giving us a whiter and larger flame than we could get from either by itself. I think that the slight tinge of yellow imparted by coal gas is an advantage, in that it produces on the eye the effect of greater luminosity. In this introduction to the paper Mr. Slater touches upon the very beautiful comparison of light and sound; and it may be of interest to some of you who have not studied the matter to know that there is a very great similarity, and that, while the figures do not correspond exactly, we understand that sound covers a certain number of octaves, and that a certain part of sound belongs to a certain number of vibrations in music, and that we can go up through a series of vibrations until we come to light. It is a curious coincidence, if it is a coincidence, that the numbers of vibrations in different colored rays in the spectrum correspond very closely to multiples of the different musical notes in octaves of music; the musical octaves extending from 16 vibrations to the second, up to 32,000. Then the high vibrations of light, which are invisible, and extending through about 22 octaves, until we come to a lower amount of light and go through the spectrum from red to violet. I mention that as a matter of interest, and as a beautiful study—the relationship between light and sound.

Before taking my seat I wish to move a very hearty vote of thanks to Mr. Slater for his very interesting and valuable paper.

Mr. F. Egner—I second the motion.

Mr. A. G. Glasgow—I would like to observe that we should be a little careful in drawing our analogies between sound and light. Sound is produced by vibrations, it is true, but by the vibration of air. For instance, you may strike a gong inside an air-tight vessel and hear it perfectly well; but when you pump the air from within this vessel you cannot hear it at all; such vibrations as exist there are those of light and heat, which are transmitted, it is supposed, by vibrations of an ethereal medium that pervades all space. Concerning intensity. The intensity of light, as we understand it, or as I understand it, is measured by the impression which it produces upon the eye, and is not at all measured by illumination. For instance, we may look at an incandescent light, and it will give to the eye an impression of highest intensity, but if you want to find out the practical value of the light as an illuminant, you should turn your back to it, and see what you can see; and it is in this instance that the matter of color comes up. A flame may emit exclusively yellow rays, and as Mr. Slater observes may, per unit of light, produce the maximum effect of illumination upon the eye; but that same yellow flame, when you are not looking at it, but are looking at other objects illumined by it, only shows up those particular objects that reflect yellow rays. If your room is filled with yellow objects, then of course yellow light has the greater advantage, but in an ordinary room filled with variegated colors, it seems to me that the light that we want is a white light containing *all* the rays, yellow as well as the others, that will reflect back whatever colors the surrounding objects happen to possess. The color of an object is indicated by the ability of that object to reflect certain rays of light and absorb others; and so to show all colors advantageously, you want a source of light which emits all the rays. You do not want it to emit only yellow rays, because your eye is more sensitive to yellow light, unless everything around you is yellow. Then you want all the rays yellow.

Mr. J. A. P. Crisfield—I would like to ask you if you believe that it would increase the amount of light in a room by surrounding it with mirrors?

Mr. A. G. Glasgow—I do. Certain articles have the power of absorbing light, but I do not think that a mirror possesses that characteristic. By the use of mirrors you certainly increase the illumination in a room, although you may not be said to increase the light—for that depends upon what you mean by "light." A great many objects in a room may absorb certain rays of light; now, if you replace those objects by mirrors, you thereby increase the illumination of the room.

Mr. A. B. Slater, Jr.—With regard to the best burner for high candle power water gas, I think it will be found, as I have found in all my experience, that the gravity of the gas must be respected as much as its candle power; and that the greater the gravity the greater proportionately must be the pressure used; and that with an increase in the illuminants the size of the opening of the burner would naturally be reduced. I think that you will find, as I did, that some of the old-fashioned Argand burners, which, with low candle power coal gas give an efficiency of about 30 per cent., with high power water gas will give a very high efficiency, because the thinner the flame the more effect you get from the illuminants that are being consumed, because none of them will be lost by being consumed in the centre, and whose emitted light would be obstructed by particles in the outer part of the flame. Therefore, a thinner flame will give greater efficiency for the gas. In regard to the effect of light on the eye, I think that we can refer back to the paper read by Mr. Jones before this Association at the former New York meeting. He there referred to the effect of different lights upon the eye, and to the sense of illumination, and stated that the sense of illumination upon the eye increased only in a very small ratio in comparison with the increase in the intensity of the light. With reference to the point of the illumination of a room, I think you may take as the definition of the illumination of an object, that it is the amount of light received by it, less that which is absorbed and directly transmitted through it; and that when you ascertain the amount of light which is reflected to the eye you are getting at the real illumination. For instance, if we have a slightly yellow flame and throw it upon an object which is Prussian blue, you will get almost no illumination at all, because the light would be almost entirely absorbed. But if you have a blue object and illuminate it with a blue flame, then you will get the maximum of illumination for that color; or if you have a yellow object you will get the maximum illumination from a yellow flame. For instance, the furniture in this room is illuminated by a flame which is slightly yellow, and it appears very light when compared with the colors of the columns and of the general trimming of the room. They reflect less light and absorb more.

The thanks of the Association were voted to Mr. Slater for his paper.

(To be continued.)

The Uses of Peat

A writer in the *Journal of the Society of Chemical Industry* prints an extract from an article by Dr. Leo Pribyl, who maintains that peat is a valuable raw material, the uses of which, except as fuel and litter, are as yet very limited. The fiber is unsurpassed as a packing material for use in the case of breakable merchandise, being much superior to straw, hay, etc., owing to its greater elasticity and dryness. In the case of consignments consisting of liquids, it possesses the advantage of being peculiarly adapted for absorbing any of the contents which may have escaped through breakage, and thus preventing damage which might result to other consignments through damp. In the shape of dust and litter it is especially adapted for preserving perishable articles. Meat when packed in it will keep fresh for weeks, and will eventually dry up, the moisture being absorbed by the peat. In this way fresh sea fish has been sent from Trieste to Copenhagen, and has reached its destination in perfect condition. Peat is also successfully used for preserving fresh fruit; even grapes may be made to retain their fresh appearance for months, and, owing to the high prices of this fruit in spring and summer, would amply repay the trifling expense incurred by the use of peat dust. Experiments have shown equally satisfactory results in the case of pears, apples, plums, etc., as also in the case of cabbage, turnips and potatoes, peat packing having the advantage, not observable with other packing materials, of preventing the sprouting of potatoes in spring. The question as to the best method of preserving eggs for the winter months is an important one, and still remains without any satisfactory answer. Possibly the preservative qualities of peat might here again be illustrated, and a satisfactory solution of this important question be arrived at.

It has been found a drawback in the use of artificial saline manure that in wet weather it forms itself into hard lumps, which cannot be scattered by the manure spreading machines, a difficulty which may be obviated by the use of a small quantity (2.5 per cent. has been found to be sufficient in the case of kainite) of peat dust with the manuring salt.

As a substitute for ashes and straw in filling up the partition walls of cellars and ice houses, broken peat is most suitable, as the effect of moisture on the ashes or straw is such as to render their immediate removal a necessary condition for the continued use of such places. Ice has been pre-

served for eight days in a cement barrel when covered with dry peat litter. Two pieces of ice were exposed to the sun's rays in Braunschweig; one of them was covered with wood shavings and the other with a layer of equal depth of peat litter. The former had thawed in 72 hours, when it was found that the latter was still almost entire. From this it is seen that peat is a bad conductor of heat, and is consequently well adapted for isolating purposes.

Peat dust has been recommended as an excellent ingredient for use in the manufacture of light, porous bricks, being mixed with the clay previous to baking. Bricks of this kind are much sought after in certain branches of architecture. But still further industrial uses are found for peat. The peat bogs of northern Germany and of Sweden are being worked by joint stock companies, with a view to obtaining the elastic fiber, which, when free from dust, is used for weaving into carpets and other textile fabrics. Considerable capital is invested in these undertakings in Oldenburg and Sweden. The paper industry, too, in the manufacture of peat cellulose, has shown a decided preference for this tender and pliant fiber, so that it may be justly said that at the present time the supply of good peat is inadequate to meet the demand, considering the varied uses of this unpretentious raw material.

The chemical industry is using peat in the manufacture of charcoal, peat coke, peat gas, etc., thus converting a cheap raw material into a valuable industrial product. Boghead naphtha, tar, solar oil, paraffine, acetic acid, and gas, have been produced from peat, and it has even been used in tanning. It has been for years used in Germany for absorbing waste liquids and refuse in factories, and in this way has furnished large quantities of valuable manure in certain districts.

An enumeration of the manifold uses of peat will prove that this raw material, which has hitherto been considered of little importance, and which nature has provided in such abundance, even if it be in many districts partially distributed, is destined not only to benefit agriculture by its valuable properties and chemical composition, but to lay the foundation of a flourishing and widespread industry. A new era has been entered upon in the sanitation of towns by using peat, and it is to be hoped that advantage will be taken of the undoubted benefit arising from its use, both as regards the health of urban populations and the promotion of agricultural interests by the supply of large quantities of manure. In this way extensive and unproductive tracts of bog land would be converted into valuable properties, and a flourishing industry would provide work and wages for thousands of hands.

Experiments With High Tension Currents.

Engineering notes that at the Frankfort Exhibition a number of very beautiful experiments were carried out by Messrs. Siemens and Halske with alternating currents of high electromotive force. These were performed by Dr. Berliner, and excited the admiration of all who saw them. The region of alternate currents of great potential is almost unexplored, but the researches that have been made show that it is full of possibilities of which no one can yet form any accurate conception. At present we are only on the very verge of the subject, which is so encircled with practical difficulties that no systematic experimental inquiries have been made. The few phenomena which have been shown have been so brilliant, and withal so unexpected, that an intense curiosity has been evoked for further information, and many minds turned to the subject. While Messrs. Siemens and Halske were delighting their friends with exhibitions reaching up to 20,000 volts, Messrs. Siemens Brothers, of London, had already pushed their experiments up to 45,000 volts, and had at the Naval Exhibition an apparatus capable of delivering a current of two amperes at this enormous pressure, that is, of dealing with the energy of 120 horse-power. For various reasons there have been very few demonstrations of the power of the apparatus, but it is intended that it shall form a prominent feature at the Crystal Palace Exhibition, where doubtless all who appreciate its importance will endeavor to see it.

It is almost impossible to convey by words any idea of the visible phenomena accompanying the efforts of a 40,000 volt current to bridge an open space, but we will attempt a description of what we saw one evening last week. Upon a table there was fixed an electrode, some 3 inches in diameter, connected to one terminal of a transformer. Over it there was mounted a large sheet of glass 3 millimetres thick, and above the glass there was a second electrode terminating in a sharp point, the distance between the electrodes being 3 centimetres. When the current was turned on to the primary coil of the transformer there first appeared a purple haze at the upper electrode, streaming towards the glass; as the current increased this haze grew in fullness and definition, and began to throw out feelers which darted outwards, and as quickly withdrew. As the electromotive force augmented still further these feelers gathered power until they beat themselves violently on the glass, as if they would force themselves through it in their mad desire to reach the other electrode. The whole space below the pointed conductor became alive with them, and exhibited a mass of leaping, crackling threads of purple fire, which writhed and twisted in impotent attempts to burst through the barrier, and failing that, spread themselves along its surface endeavoring to rush over its edges, and so reach their goal by a circuitous route. But this was beyond their strength until the electromotive force approached 45,000 volts, when suddenly the entire appearance was changed. The current overleapt the edges of the plate and flowed completely round it in all directions. At that moment the intense purple color of the spark disappeared, and was replaced by white light of the greatest brilliancy, which surged and scintillated in a way that produced acute fatigue of the eyes in an extraordinarily short time. Although steadier than before, the discharge still kept up its spark-like character, enfolding the glass plate in gleaming coruscations, which glistened and flashed until the spectators were fain to turn away their bedazzled gaze.

A change in the arrangement was then made. The upper pointed electrode was replaced by a brass disc 3 inches in diameter. This was laid over the surface of the glass plate with three very thin washers of vulcanite intervening between the two. The current was then turned on, in the same gradual manner as before. The space between the two discs immediately filled with purple light, which had sufficient motion in it to recall the flame of a Bunsen burner, spread out under the bottom of a beaker. Sparks then began to appear at the edges, and, as they gathered strength, to radiate a little beyond them. Gradually they became streamers stretching out along the surface of the plate, in curved fanciful forms which twined and twisted, and weaved themselves into a glistening filagree, compared by an imaginative spectator to an agonized Japanese chrysanthemum. This experiment had not the brilliant refulgence of the one that preceded it, but was characterized by a quivering irradiation which writhed and tossed like a bird beating itself at the bars of its cage. In spite of its less formidable appearance, however, it proved destructive to the glass, which presently flew in pieces with a crash. Several sheets were tried in succession, but each was pierced and broken, and allowed the current to attain its object of flowing directly from one electrode to the other.

The last demonstration showed an arc under a pressure of 44,000 volts. When the electrodes approached to within 5 inches the arc established itself, but instead of the flames bridging the space they streamed out in two thin tongues at right angles to the electrodes and parallel to each other. If the electrodes were pushed nearer together the flames deserted their extremities and wandered back along their stems, evidently repelling each other. The light produced was, of course, very small indeed.

In conclusion we may add that the voltage was reached by two transformations. An 80-volt current was first raised to 2,000 volts by one of Siemens' cable transformers, consisting of a long core of wire rope, composed of soft iron wires covered with a layer of specially prepared insulating material, around which are wound two insulated conductors forming, one the primary and the other the secondary circuit of the transformer. The secondary current was then raised to 45,000 volts by by a transformer of the usual type.

Incandescent Gas Lights.

An English patent (No. 5,022) granted to Mr. J. Moeller, of London, covers an invention (according to the London *Journal*) that relates to "the production and application of a combustible fluid mixture of air and hydrocarbon vapor, available for ordinary illumination in localities where gas cannot be obtained, and applicable also for heating or producing the brilliant light known as the incandescent gas light."

When the fluid mixture is to be used in ordinary burners, instead of gas, for impregnating air, the inventor employs liquid hydrocarbons of the benzoline class, of specific gravities varying from .620 to .670. When the fluid is to be used in a burner of the Bunsen kind for heating generally, or for raising to incandescence a refractory hood or mantle, heavier liquid hydrocarbons are used, of specific gravities varying from .680 to .720. In either case, the same apparatus is needed for supplying and impregnating the air with the hydrocarbon vapor, and governing the pressure of the fluid mixture.

Fig. 1 is a longitudinal section, and Fig. 2 a transverse section of the combined air supplying, carbureting, and governing apparatus.

The air supply is effected by the revolution of a drum B, partitioned like that of a wet gas meter, more than half immersed in water, within a casing B^1, through which air is drawn in at S, and, passing through the compartments of the drum, is caused to issue by a channel D to the carbureter below. This is a vessel placed within a water-casing W, and containing in its lower part the hydrocarbon liquid O, the level of which is indicated by the steam of a float F, visible in a glass tube F^1. Within the vessel is a horizontal revolving shaft C^1, having fixed on it a drum C of perforated metal with perforated radial partitions. Fibrous material—such as cotton or wool—is loosely turned over the partitions and around the drum. As the drum revolves partly immersed in the hydrocarbon, the cotton or wool becomes soaked with the liquid; and the air passing through and around the drum (as indicated by the arrows) takes up a quantity of the vapor, and the mixture of air and vapor passes by a pipe D^1 to the governor. The water in the casing W of the carbureter, besides adding to the safety of the apparatus when comparatively light hydrocarbons are being used, serves also to prevent refrigeration resulting from the evaporation of the hydrocarbon; and in order more fully to provide against this in cold weather, the casing may communicate with a tank containing a considerable body of water.

The governor consists of a vessel R containing water in the annular space around an inner compartment R^1, in which is arranged a valve V, having its stem attached to a floating-bell R^2, which dips into the liquid below. The combustible mixture of air and benzoline vapor passes through the valve into the bell, and thence by a pipe I to supply the light. As the pressure in the bell increases, the bell rises and more or less closes the valve V, allowing less of the gaseous mixture to pass into the bell. The pressure of the supply to the lights is thus regulated according to the load on the bell.

Fig. 1.

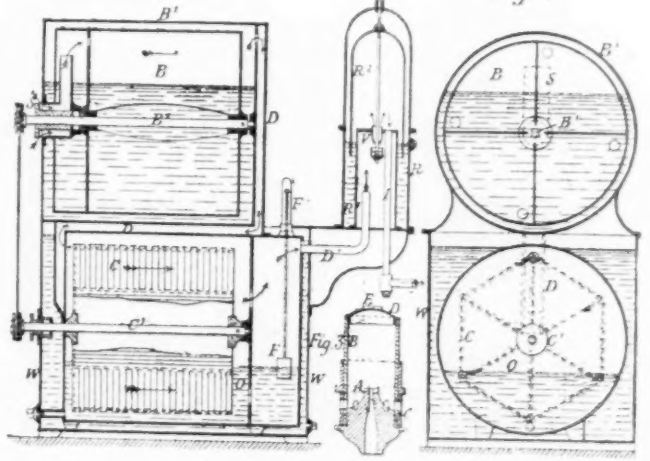


Fig. 2.

The regulating valve V may be of the paraboloid form commonly employed for bell gas governors. It is preferred, however, to use a valve such as is shown in Fig. 1, consisting of a cup containing mercury suspended from the bell R^2, and a stationary tube projecting down into the mercury. This tube has a V shaped opening at its side (or several of them) so that the more deeply the tube is immersed in the mercury, the less passage is afforded through the openings in its side. The shaft of the revolving carbureter C is driven by chain gearing from the shaft B^1 of the blower B; and this shaft may be driven by any convenient motor—such, for instance, as a weight or spring which is from time to time wound up, and which by suitable gearing drives the shaft at a speed determined, within certain limits, by the quantity of combustible fluid consumed. Thus, when the cock on the pipe I is fully open, a considerable quantity of gaseous mixture can pass without increasing the pressure in the bell, and the blower and carbureter can revolve at their maximum speed. When, on the other hand, the cock on the pipe I is closed, the pressure resisting the movement of the blower increases until the weight is no longer capable of driving it.

The burners employed when the air is carbureted by the lighter qualities of hydrocarbon are of the ordinary kind used for gas. When the heavier qualities of hydrocarbon are employed to carburet the air, the burner employed must be of the Bunsen kind.

Fig. 3 is a vertical section of a burner of this kind, which is especially applicable for heating to incandescence a refractory mantle. A is the nozzle by which a jet of the combustible fluid mixture issues into the tube B, into which air enters by lateral holes governed by a rotating valve C. The top of the tube is covered by wire gauze D, the central portion of which is closed by a button E. The mixture of air and combustible fluid issuing through the wire gauze, being ignited, produces a flame of great heating power, which may be applied for heating to incandescence a refractory mantle supported above the burner.

Doctor Shaw on Municipal Lighting.

Our issue for Nov. 2d contained an item respecting a lecture recently delivered by Dr. Albert Shaw before the Johns-Hopkins University, historical division. Having obtained a fair abstract of the Doctor's remarks, we herewith reproduce the same:

The arguments for a municipal control of the gas supply are less numerous than those for a city water supply, which I quoted yesterday. One argument for private gas works is that the supply of material for illumination is much more strictly a commercial undertaking than the supply of water, which concerns the health and comfort of the whole population. You cannot prove the necessity of municipal control by the same arguments as those used for a municipal water supply. The real argument, it seems to me, is that a cheaper and more efficient service may be obtained by the city, in addition to other benefits which would be of no advantage to a private company.

The best places to study the practical results of a municipal gas system are in the towns and cities of Great Britain. German cities likewise furnish instructive points of comparison, but the problem being worked out in England is nearer to our own needs than the German gas question. In two-thirds of the towns of Great Britain there exists a direct manufacture and sale of gas by the municipality as an exclusive monopoly product. This includes most of the large cities. The proportion of gas actually manufactured and sold by British local authorities is decidedly greater than that manufactured and sold by private companies. The three great private gas companies of London help to swell the sum total of the output of the private works, but the authorities of the metropolis are now endeavoring to buy out both the water and gas supplies. The city is at present divided off by an amicable arrangement of the three companies; if it were not, the consumers would have to pay for a useless duplication of plant.

I may say right here that European cities have never labored under the delusion—so common in most of our American cities—that any good came from permitting two or three rival gas companies to lay mains in the same streets in the hope of securing cheaper gas. There will result from such a step either needlessly high prices for gas in the ultimate consolidation of these companies, or a perpetual attempt to pay dividends on deeply watered stock. Disaster has invariably resulted in our American cities from such a false step. The best policy would be to let the private company have a monopoly, and then regulate it for the people by some good means of municipal supervision.

The charge for gas in English cities is 50 to 75 cents per thousand feet. The amount of gas manufactured and the nearness to the coal fields regulate the price for both private and public works. Obviously it would not do for private companies, with examples of good municipal gas manufacturing around them, to charge much more for gas than their neighbors. The municipal gas supplies perhaps tend to be a little cheaper, but are much more likely to give good measure, a better quality of gas and better accommodations in supplying meters and pipes, and in supplying gas to tenement houses. Where the gas is in charge of the public authorities its dissemination is much more thorough, and fewer people will be found using candles than in cities where private companies operate. In Glasgow the private works were bought out about 20 years ago, and the policy there has been to make no large profits, but to constantly extend their use by steady reduction in price. This has brought the price down from $1.14 per 1,000 feet to a little over 60 cents. There was a good round sum paid for the works, and there have been many improvements and extensions, but at the same time it has been possible to pay a good interest on the plant, to almost repay all the principal on the bonds which were issued for the purchase, to accumulate $1,500,000 in the sinking fund, and lastly, to make it self-supporting. In addition to this, while the city population has increased only about 20 per cent. in the 20 years, the number of users of gas has increased 140 per cent.

Nearly all of the other English cities operate their plants with a view of securing good profits. In the manufacturing town of Bolton the yearly profits are $140,000 net. The gas is no cheaper than under private control, but the streets are better illuminated and cash is annually turned into the city treasury instead of into private pockets. The profits of Manchester amount to $250,000 annually, while all the streets of the city are lighted at no cost at all, a saving of $150,000 more. In Rochdale, a town of co-operation and other industrial reforms, the yearly surplus is $65,000, which is applied to the reduction of the ordinary municipal taxes. The profits in Salford are from $175,000 to $200,000; in Leicester from $130,000 to $140,000. Nottingham annually saves $125,000, while charging only 50 cents a 1,000 feet.

Let us sum up the benefits of municipal control in the gas supply of English cities and towns. First, it has steadily crowded down the price, so as to allow the use of gas to to the poorer portion of the population; second, it has compelled private companies in neighboring towns to do the same for fear of an assumption of their works by the local authorities; third, it has raised a distinct and large annual revenue, which in many cases has been used to lessen the general tax rate; fourth, it has provided a better and more thorough illumination of streets; fifth, in Glasgow, it has lighted the common stairs and hallways in all houses where two or more families reside. This was a good police measure, but it was found to be impossible to get the landlords to do it, so the city undertook it, defrayed half the cost and taxed the landlords for the remainder. This was quite unprecedented as a public step, but its success has been such that Edingburgh has recently undertaken it, and Liverpool and other cities will probably follow in the near future. It is something which never could have been done with gas operated privately.

In the German cities the supply is as yet about two-thirds public and one third private. Berlin, Hamburg, Breslau, Cologne, Leipsic, Koenigsberg and Nuremberg are among the cities supplied with public gas, while Munich, Frankfort-on-the-main, Stuttgart and Hanover are the leading towns with private gas companies. The financiering in the public works is very careful and very good, and the Germans, in their thrifty way, make the supply of gas a good source of revenue. The people are poor and already burdened with taxation, and it is obvious that the municipalities must have these profits, so that the people need not be crushed under the weight of taxation. The tendency toward public ownership is not because the gas supply is regarded as a great social advantage, as it is in England, but because it assists in reducing the direct taxes. Hence the rates are not lowered very much.

With regard to American cities I can only say that the municipal control of gas in Richmond, and in Wheeling, and the great gas trust of Philadelphia have, upon the whole, justified the assertion that public control in this country may prove beneficial.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE following is the text of the decision of the Supreme Court of Iowa, in reversal of the opinion of the lower courts, respecting the case of Graves vs. the Key City Gas Company, of Dubuque, Iowa, the earlier history of which was given in these columns. The Court said :

"The resolution of the Directors of defendant, we think, expresses in unmistakable language a contract whereby it became bound to furnish plaintiff gas for ordinary purposes, including gas log in library and two street lamps to be used in plaintiff's dwelling and buildings for a period of 20 years, if Graves or his family occupy the building that long. The validity of the contract, we think, cannot be doubted, and its language, when interpreted under the rules of law, expresses with sufficient clearness the agreement of the parties. The defendant under the contract undertakes upon conditions before recited to furnish gas to plaintiff as provided for in the contract. The gas is furnished from pipes running from the mains, presumably owned by defendant, into and through plaintiff's dwelling and premises. The refusal to supply the gas is not only a breach of contract, but is in effect an interference with plaintiff's enjoyment of his property by its use as contemplated by the parties when they entered into the contract. Plaintiff, by his contract, provides for gas to be used for illuminating and other ordinary purposes. If defendant may withold his supply of gas plaintiff may obtain it from no other source, for defendant, it appears, has in effect at the present time, a monopoly of the right to furnish gas to private consumers, such as plaintiff. His gas pipes and gas burners and fixtures would become useless and valueless, and he would be deprived of gaslight which, to a certain extent, is regarded by housekeepers using it, as a necessity and a source of comfort. As plaintiff can supply his dwelling, outhouse, street lamps, in no other way, this injury cannot be repaired. If defendant supplies him with no gas he must do without it and the comfort it brings. It is true he can use candles, oil or electricity, but he contracted for gas light and is entitled to it. It will not do to say he may have a compensation in damages. If it might be done there would be delay in compensation, subjecting plaintiff to discomfort, inconvenience and loss for probably a protracted period. Equity will not permit one to be deprived of his right in this way by the violation of a contract, but by injunction will interfere to prevent it. It is insisted that as the plaintiff violated the contract for gas by using a quantity largely in excess of the amount provided for by the contract, the defendant may cut off the supply and deprive him of the use of all gas. Such deprivation would extend to some gas burners—the street lamps for instance, through which it is not shown excessive quantities of gas was used. Plaintiff insists that his use of gas has not been excessive or wasteful—as contemplated when the contract was made. It is true the evidence tends to show a large use by plaintiff, but if such use of gas was made by plaintiff with the knowledge of defendant, without complaint or objection on account of the alleged excess, the defendant thereby acquiescing in such large use and putting a construction as to the quantity authorized to be used, ought not to be permitted to disregard its acquiescence and take the law in its own hands, and enforce its claims by disregarding its contract according to the interpretations it had put on it, puts the laboring oar in the hands of defendant. It must establish its interpretation of the contract and its right thereunder upon a trial of the issues of the case. If it be made to appear upon the law and the facts as developed in the case that defendant is entitled to relief of some character, the law will not permit it to help itself to that relief, and deprive plaintiff of all gas contemplated by the contract. It is insisted by defendant's counsel that after the injunction was refused on the first application, the plaintiff under code, section 33-92, on other application, presented a different case, in that it showed that the defendant had cut off all gas from plaintiff's premises. The first application showed only a threat. In our opinion the court erred in refusing the first application, and, the petition having been amended, the second application ought to have been allowed. The defense leased upon the garnishment in the U. S. Court surely is no ground for refusing plaintiff relief. Neither reason nor authority is adduced in its support. It may be further said that there is no evidence before us supporting this defense. We reach the conclusion that a temporary injunction ought to have been allowed in the case. As we have intimated, there is evidence which it is claimed intends to show that plaintiff has been using excessive quantities of gas. If after the injunction is allowed there be in fact an excessive use not authorized by the contract, defendant will be protected by the injunction bond against loss on account of such future use. The cause will be remanded to the court below for the allowance of a temporary injunction and other proceedings in harmony with this opinion. [Reversed.]"

IT is reported that the Atlanta (Ga.) Electric Light Company has made an agreement with the Thomson-Houston Electric Company whereby the former acquires all the interests in the State of Georgia hitherto possessed by the latter.

MESSRS. A. M. YOUNG, E. H. Jacobs, R. S. Hicks and Senator Shumway have incorporated the Stafford Springs (Conn.) Electric Light and Gas Company, and will at once engage in the supply of electric lighting for that place. Water power from the Willimantic river will be employed. Stafford Springs is a post borough in Stafford township, Tolland county, Conn., and is at the junction of the headwaters of the Willimantic river. It is 37 miles northwest of Norwich, and 25 miles northeast of Hartford. It has a population of about 4,800, and is noted for the presence of springs, the medicinal qualities of the waters of which are in great repute.

ON the petition of Mr. George W. Lothrop, the Town Council of North Smithfield, R. I., has authorized the Woonsocket Gas Company to extend its mains to Union village.

THE suit brought by F. B. Owens, against the Washington (D. C.) Gas Light Company, in which complainant asked for $10,000 damages, alleging that he was injured to that amount through the negligence of the Company, resulted in a verdict for the defendant. The case was tried before a jury in the Circuit Court.

THE proprietors of the Meriden (Conn.) Gas Light Company will run a new leading main (12 inches in diameter) from the works on Cooper street, through South Colony to Main street.

THE Rochester (N. Y.) *Advertiser* says that a mortgage and trust deed from the Rochester Gas Company to the Knickerbocker Trust Company was filed on the last day of October. The bond is in $400,000, and the money is to be used in extending and enlarging the plant formerly operated by the Citizens Gas Company. The mortgage covers all the real property and franchises of the Company.

THE proprietors of the Honesdale (Pa.) Gas Company have voted to expend the sum of $15,000 in improving the works.

IT is understood that parties are negotiating with Mr. C. C. Crandall, of Boston, for his controlling interest in the properties of the Medina (N. Y.) Gas and Electric Light Company.

WE are indebted to a correspondent for the following, under date of the fifth inst. "A part of the property of the Atlanta Gas Light Company was advertised to be sold for taxes, but the sale did not take place. Mr. J. W. Lloyd, the City Marshall, had issued an execution against some of the Company's property, and, but for the opportune interposition of Judge Clarke, it would have been knocked down under the auctioneer's hammer. The reason why the Gas Company was in arrears in the matter of taxes, was not because of inability to pay, but because the Company's officers objected to paying them ; and the reason why this objection was made is, the Company holds that according to the terms of its original charter it is clearly exempt from taxation. Messrs. Jackson & Jackson, attorneys for the Company, will test this question in the Courts, and the case will be brought to the Court of last resort to finally settle the question. The issue sought to be settled is not a new one. It has forced itself to the public notice several times before, but has never yet been definitely settled. Atlanta was, for the first time, lighted by gas on Christmas night, 1855, and the Atlanta Gas Light Company which supplied gas first to the city, was chartered on April 5, 1855. The original contract between the late Mr. William Helme, of Philadelphia, on the one part, and the city of Atlanta on the other part, is a most interesting document. Under it, the Company agreed to erect certain buildings, and install therein the most approved form of gas apparatus, the city agreeing to subscribe $20,000 in the Company's stock. The Company was not to charge consumers 'in excess' of 50 cents per 100 cubic, or $5 per 1,000 cubic feet, and the city was not to be favored in the matter of selling rates. Another item in the contract, on which the present litigation hinges, is the following: 'The Mayor and Council of the city of Atlanta do hereby covenant and agree to subscribe $20,000 to the gas works by issuing bonds ; the Company to have the exclusive privilege of lighting the city for 50 years, and to be exempt from taxation.' The charter bears the signatures of Allison Nelson, Mayor of Atlanta, of William Helme, and of A. W. Jones, Notary Public. The charter was confirmed by the Legislature, in 1856, and it still exists essentially as it was originally drawn. The Company has passed through many varying phases of fortune, but it has always re-

tained its original name, and its plant, which at one time was valued at less than $25,000, now is worth easily $500,000."

THE proprietors of the Yarmouth (Nova Scotia) Gas Light Company have determined to add an incandescent electric light complement to their present arc lighting plant. The understanding is that the addition will be in working order by March 1st.

FROM the reports of Mr. R. B. Wilson, inspector of gas and illuminating oils for Baltimore, Md.—his reports are submitted weekly—it is seen that a close watch is kept on the safety of the illuminating oils offered for sale in that city. For instance, taking the last weekly report for October, we find that in that week Mr. Wilson devoted his attention to the oils offered at retail in the shops in the southwestern district of the city. He tested 120 samples, and of these 114 flashed at points above the standard, varying from 1° to 9°, plus—the standard is 120° F. The remaining six samples flashed at the standard.

SOME time ago, the authorities at Lincoln, Nebraska, in the belief that the local Gas Company was supplying a gas below the requirements of the statutes, determined to have illuminating power tests made at short intervals on public account. Accordingly, a photometric station was established and equipped, and the good work went on. The first expense, however, was pretty steep, and the salary of the photometrist was also somewhat of a burden. Possibly the authorities could have sustained the cost with equanimity did the photometer and the photometrist show and report that the Gas Company's product was not up to standard, but the reality was that the gas was good—in fact, far ahead in value of that called for by the law. This was too much; the authorities had paid for a boomerang. In due time the photometrist was released, and the station was closed, and the sequel to it all is that the Lincoln Gas Company will purchase the city's photometric apparatus. Thus are we treated to another example of the eternal fitness of things.

THE Framingham, Gas, Fuel and Power Company, of South Framingham, Mass., is augmenting its business rapidly, some 30 consumers having been added to its lists in the last quarter. The new comers, too, include some of the largest business houses in the place—for instance, the local branch of the Adams Express Company, the stables of J. H. Goodell, the shop of Clifford Folger, and so on.

THE Pacific Gas Engine Company, of San Francisco, have recently placed a 15-horse power gasoline engine in a coasting vessel owned by Captain Low, and an engine of similar power has been ordered by Mr. Pitts, of Oakland, Cal., for a 35-foot launch that he is building.

TENDERS will be received at the City Clerk's office, Victoria, British Columbia, up to 4 P. M. of the 21st inst., for 600 tons of cast iron pipe, of the following diameters: 200 tons of 4 inch; 150 tons of 5-inch; 150 tons of 6 inch; 100 tons of 8-inch. The pipe is to be delivered on or before May 1st, 1892.

A DEED was recently recorded in San Francisco, by which the California Electric Light Company assigned its electric light plant, realty, franchise, etc., to the Edison Light and Power Company for $1,000,000. The instrument is dated July 1, 1891, and specifies the conveyance of realty, consisting of the lots of land, including the electric light plant on Stevenson street, west of Third, a lot on Third and Jessie, and another at the corner of Clarence and Townsend streets. Two franchises granted by the Supervisors for laying conduits for the transmission of electricity, and all the patent rights for the distribution of light, heat and power owned by the Company are also conveyed, subject to a mortgage of $300,000 held by the California Safe Deposit and Trust Company, issued on January 3d, 1888, which indebtedness the Edison Company agrees to assume.

WE are in receipt of the following respecting the determination of the proprietors of the Alton (Ills.) Gas and Electric Company to go on with the work of equipping the electric lighting station: "Evidently there is to be no more delay in the matter of putting in the fine electric plant which Superintendent Tracy has been promising since spring. The long delays, liable to be the case in matters of this kind, have been unavoidable, but President Underwood, on the 2d inst., authorized the immediate purchase of apparatus, etc., necessary to complete the contemplated extension of the plant. He was greatly pleased with the appearance and prospects of Alton, and said he felt sure the city would justify the expense. Superintendent Tracy, in carrying out his instructions, has purchased apparatus equal to the supply of 50 arc and 650 incandescent lamps. The Company's present plant is equal to the supply of 35 arcs. The Company has also purchased lots 9, 10 and 11, block 62, of the city. As these lots lie on Plaza street, directly fronting the railroad, a switch will enable the carrying of coal into the sheds without a second removal. The contract for drawing up plans for the large new power house is in Architect Pfeiffenberger's hands, who will have them ready in short order. Ground will at once be broken for the foundations, and Superintendent Tracy says, regardless of wind and weather, that the new plant will be in operation by January 1st."

IT must not be thought that the boiler explosion that wrecked the electric lighting annex of the Louisville Gas Light Company occurred in the Company's new and complete station on ground close to the gas works. The scene of the disaster was the station of the old Louisville Electric Light Company, whose plant and franchises have been under the control of the Gas Company for some time—the result of a purchase that was reported in the JOURNAL.

MENTION of this brings out an interesting fact bearing upon the probable effect of electric lighting on the send out of the Gas Company. Following the explosion, which occurred at an early evening hour, thus giving scant time to light users to notify the Gas Company to supply them with gas, came a demand for gas meters. Mr. Barret and his staff lost no time in replying to these calls, and the result was that the send-out for the 24 hours following the explosion, as compared with that for the 24 hours preceding it, showed an increase of 8½ per cent.

ADVICES from Montreal are to the effect that the Gas Company is perfecting plans, the carrying out of which will necessitate extensive additions to both divisions—the Hochelaga and Ottawa stations—of the Company's works. With these completed, Mr. Scriver will be enabled to order a marked reduction in the gas rate, and we may confidently look forward to such a promulgation next spring.

AN explosion occurred in the generating room of the Tiffin, O., gas works, on the 4th inst. The damage was not serious.

EARLY this month an accident accurred at the works of the Lexington (Ky.) Gas Company, that caused the supply of gas to give out at an hour before the residents were accustomed to retire. The following evening, however, they could remain "up" as long as they liked—the gas supply was equal to keeping them company.

THERE is some talk of shutting down the gas plant at Lee, Mass.

THE new holder, with a capacity of 300,000 cubic feet, the contract for which was awarded to Messrs. R. D. Wood & Co., of Philadelphia, by the proprietors of the Waterbury (Conn.) Gas Light Company, has been completed. Another important bit of plant construction that occupied the attention of Superintendent E. H. Williams was a capacious set (four boxes) of purifiers.

THE Mayor of Mobile, Alabama, (Mr. Rich) is a believer in the idea of intrusting the public authorities with the duty of generating and supplying electric currents to be used for purposes of public lighting. To that end he has been collecting "facts and figures" from cities and towns engaged in this work at the present time, and he concludes, from responses received, that Mobile is paying too high a figure for arc lighting to the local contractor—The Progress Electric Lighting and Power Company. Under the contract with the latter, Mobile pays $91 per annum, for 2,000 candle power arcs, on a lighting table averaging 6¼ hours per night; 181 lamps being the number maintained. As this means a total expenditure per annum of $16,471, the Mayor, from the information at his command, asserts that $50,000 would equip the city with an electric lighting plant fully up to the needs of the place, and that as the total expense—interest included—of operation would not exceed $11,000 per annum, the city would in less than 10 years have the plant paid for, because of the saving between the cost of lighting under the present plan and that proposed. He also asserts that the rate of cost proposed by him would give the city all night and every night lighting, instead of the partial lighting now obtained. The Electric Company's contract expires June 18, 1892.

THE authorities of Cleveland, Ohio, ask for bids for the public lighting of the city by gas, gasoline and electric lamps, for the period of one year, beginning January 1, 1892. The competition will close at noon of the 25th inst.

THE authorities of Wilmington, Del., levy a tax of $1 upon every electric lighting pole erected in the city.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

November 16.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	99	100
Central	500,000	50	—	90
" Scrip	220,000	—	95	100
Equitable	4,000,000	100	120	123
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	119	121
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co —				
Common Stock	5,000,000	100	40	45
Preferred	5,000,000	100	—	82
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	106	—
Citizens	1,200,000	20	—	80
" S. F. Bonds	320,000	1000	—	103
Fulton Municipal	3,000,000	100	118	—
" Bonds	300,000		102	—
Peoples	1,000,000	10	65	—
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	95	97
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	125	—
" Ctfs	700,000	1000	100	—
Williamsburgh	1,000,000	50	110	—
" Bonds	1,000,000	—	106	—
Out of Town Gas Companies.				
Boston United Gas Co. —				
1st Series S.F. Trust	7,000,000	1000	84	86
2d " " "	3,000,000	1000	70	74
Bay State Gas Co. —				
Stock	5,000,000	50	—	56
Income Bonds	2,000,000	1000	98	102
Buffalo Mutual, N. Y.	750,000	100	105	110
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds	45,000	—	—	—
Chicago Gas Company	25,000,000	100	58¾	59
Chicago Gas Light & Coke Co. —				
G't'd Gold Bonds	7,650,000	1000	82	82½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	97½
People's Gas and Coke Co., Chicago —				
1st Mortgage	2,100,000	1000	—	100
2d "	2,500,000	1000	94	94½
Consumers Gas Light Co., Jersey City	2,000,000	100	12	15
Bonds	600,000	1000	70	75
Cincinnati G. & C. Co.	7,000,000	100	—	200
Consumers Toronto	1,000,000	50	169	172
Central, S. F., Cal			90	—
Capital, Sacramento, Cal			58	
Consolidated, Balt.	11,000,000	100	45¼	45¾
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	110
Bonds	250,000		—	—
East River Gas Co., Long Island City	1,000,000	100	100	105
Bonds	500,000	100	100	102
Hartford, Conn	750,000	25	109	114
Jersey City	750,000	20	180	200
Louisville, Ky	2,570,000	50	125	130

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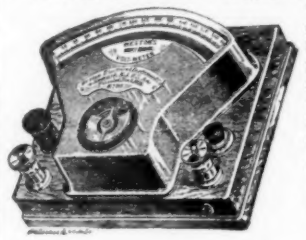

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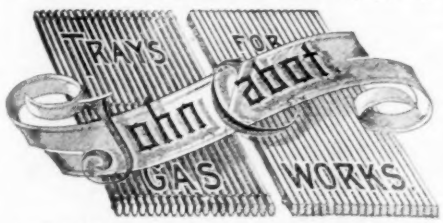

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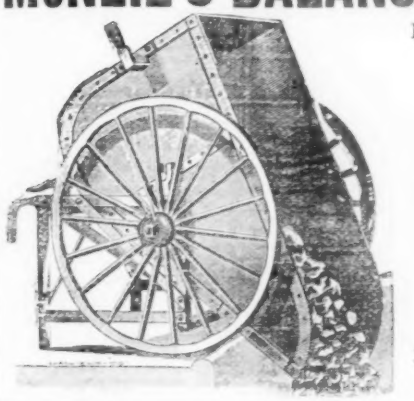

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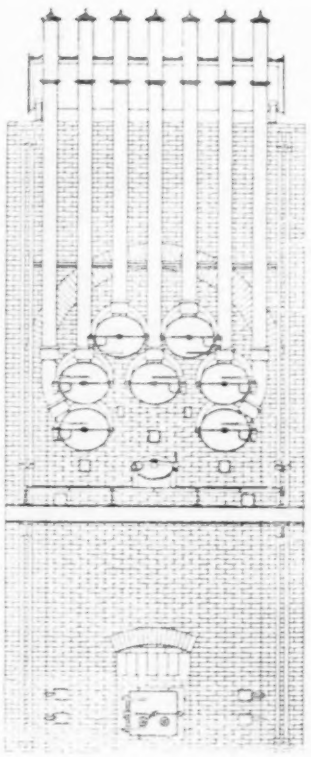

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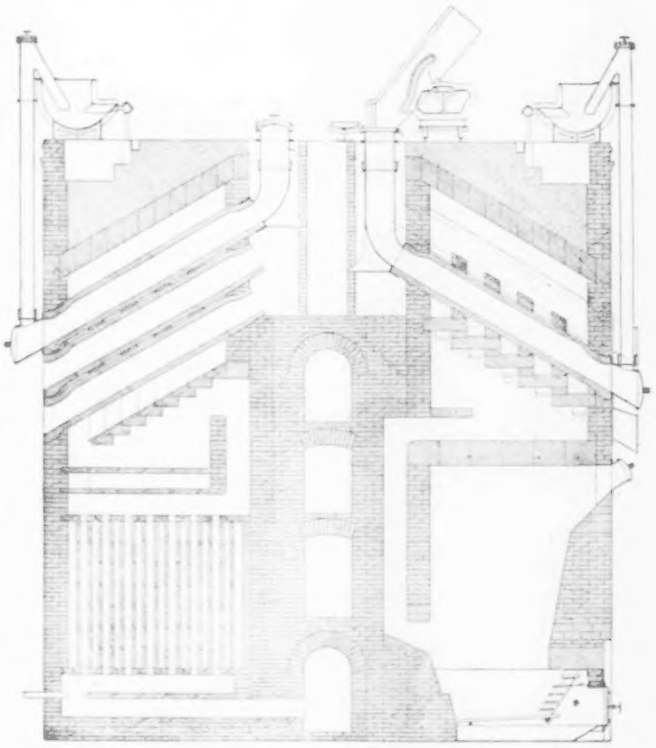

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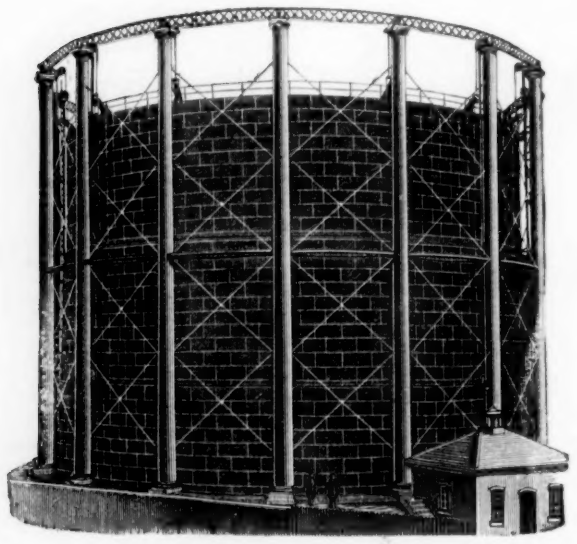

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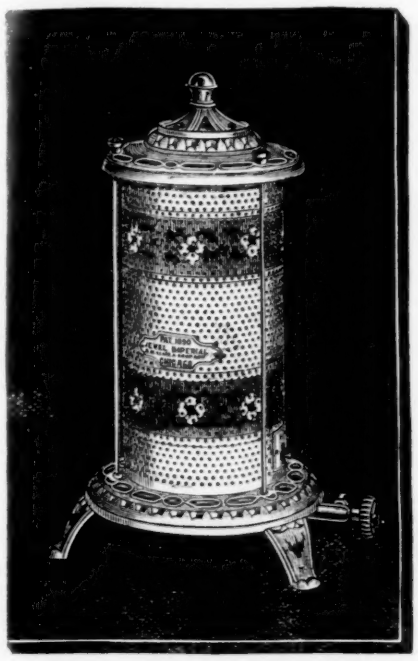

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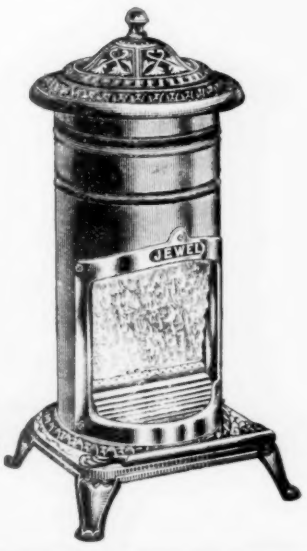

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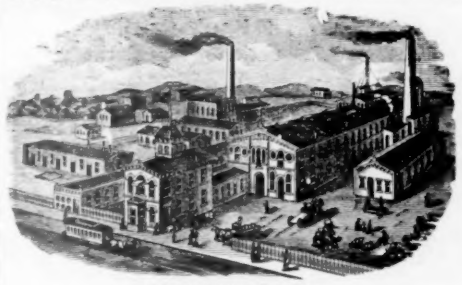

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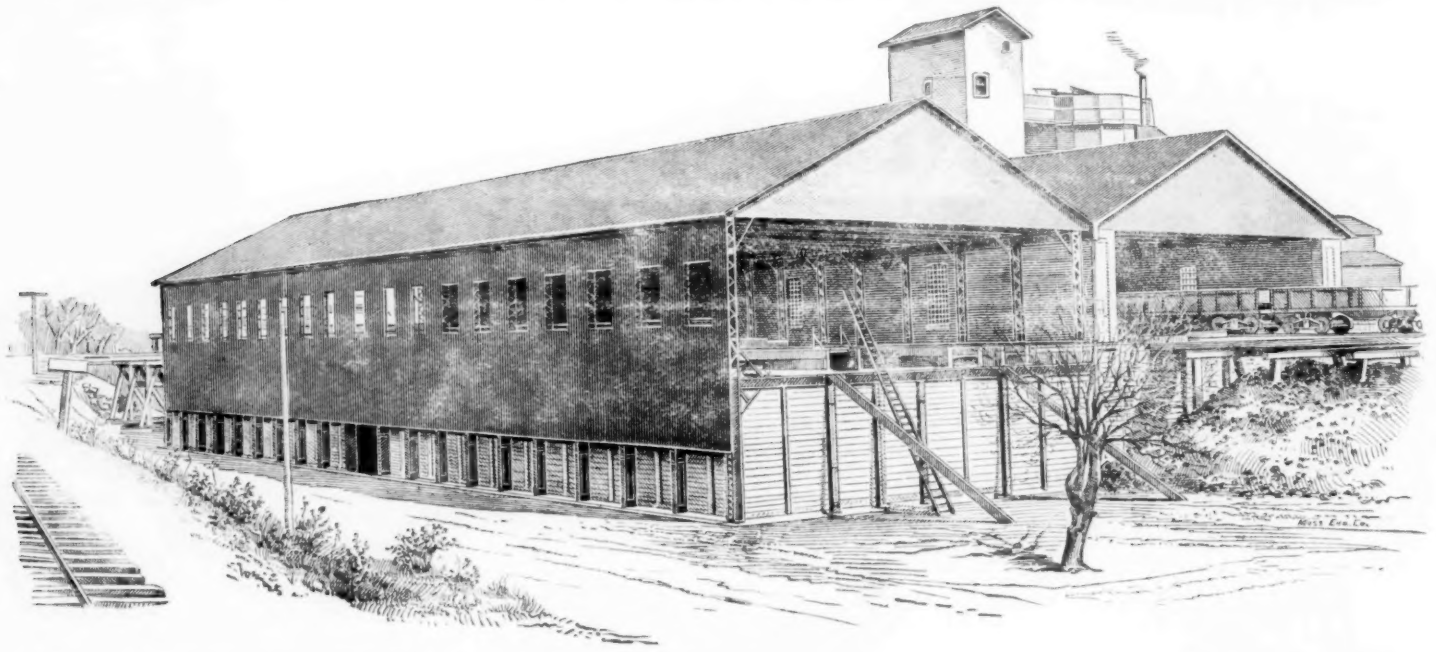

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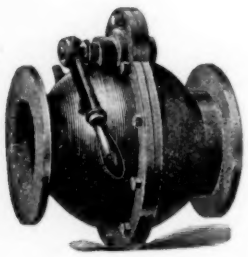

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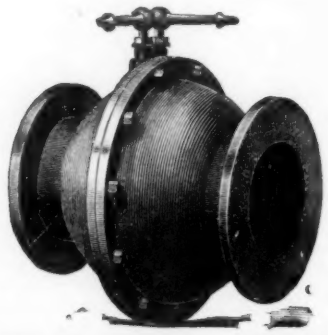

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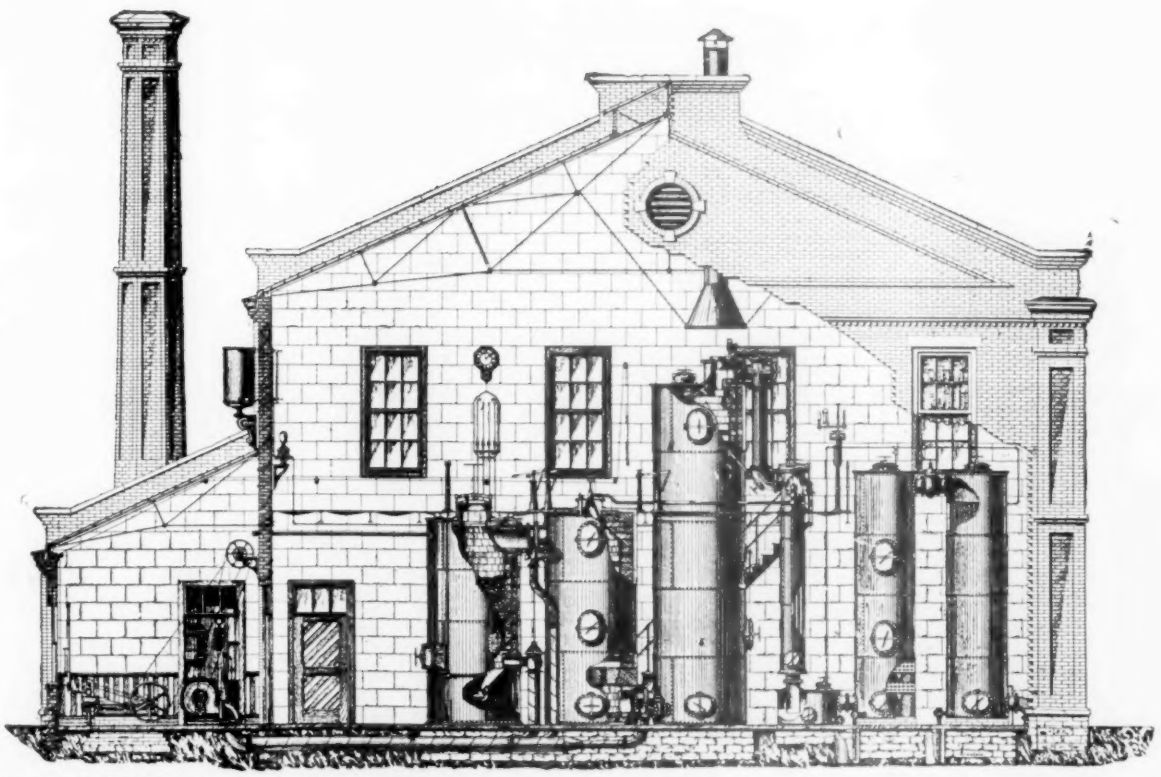

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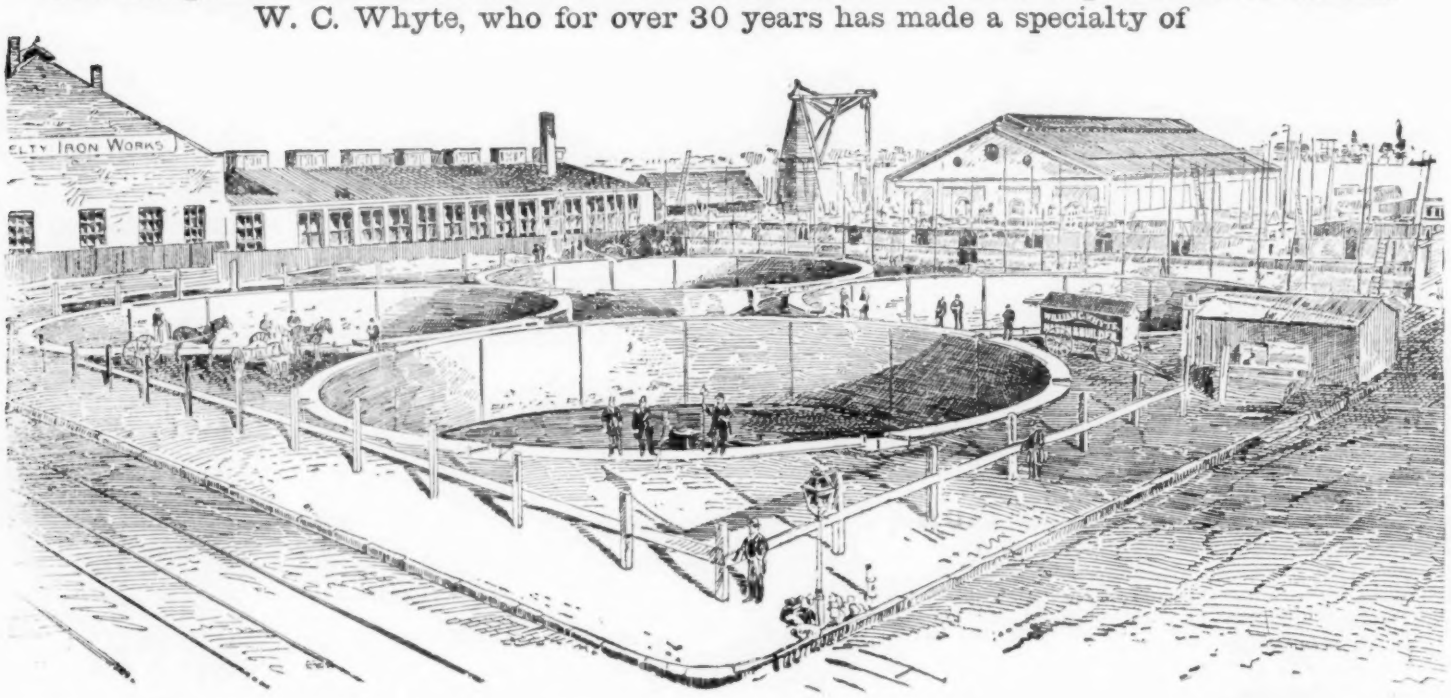

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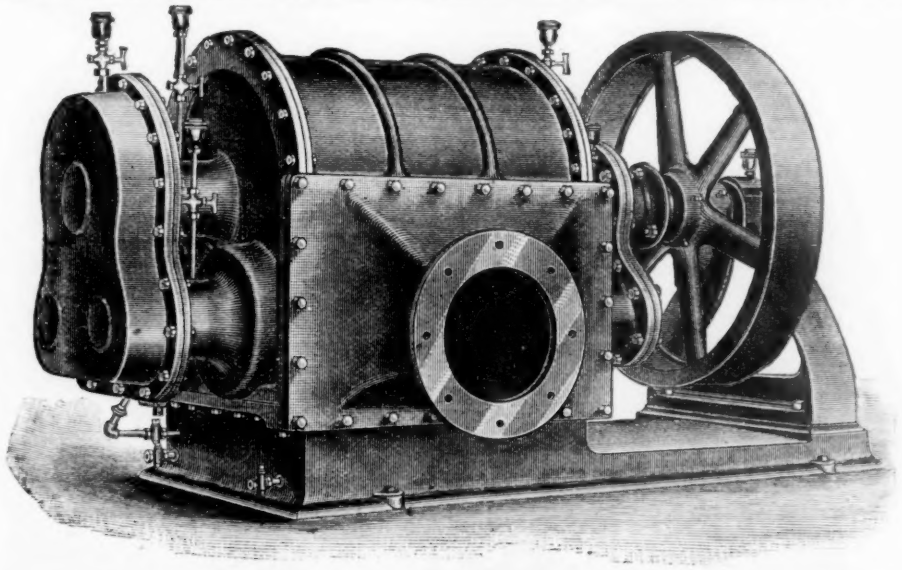

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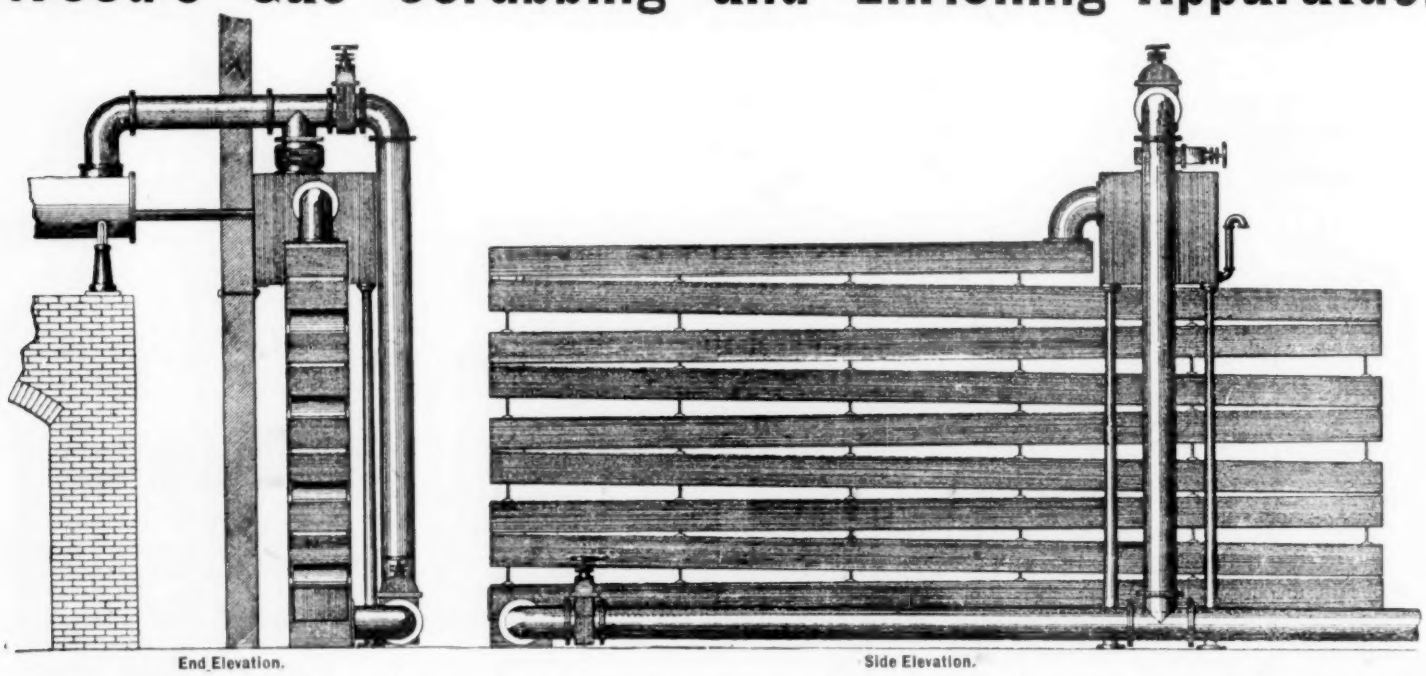

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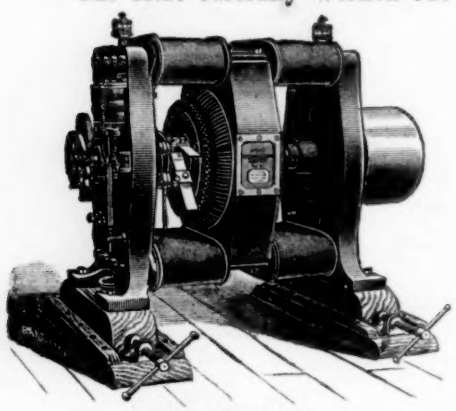

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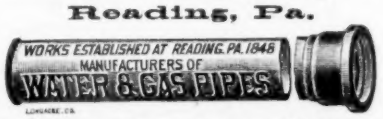

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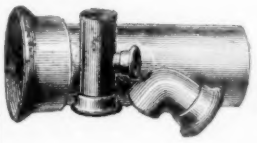

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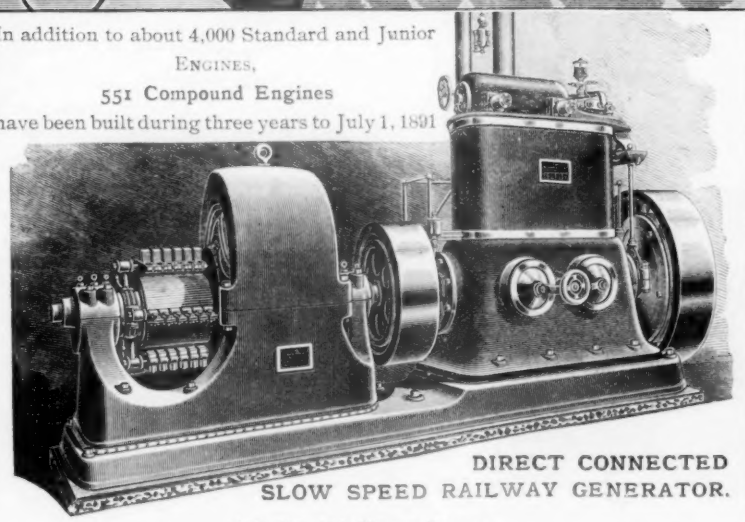

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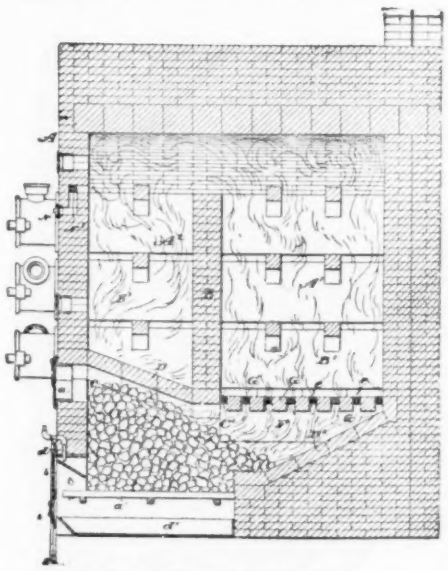

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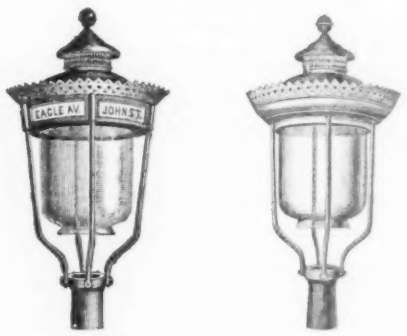

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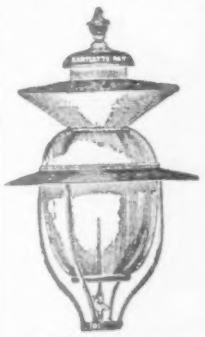

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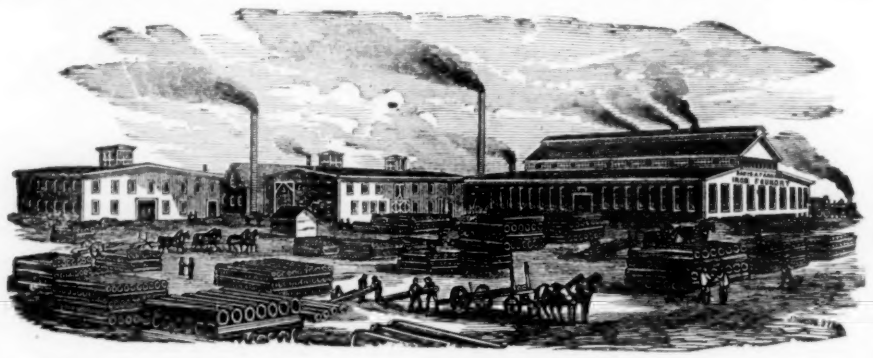

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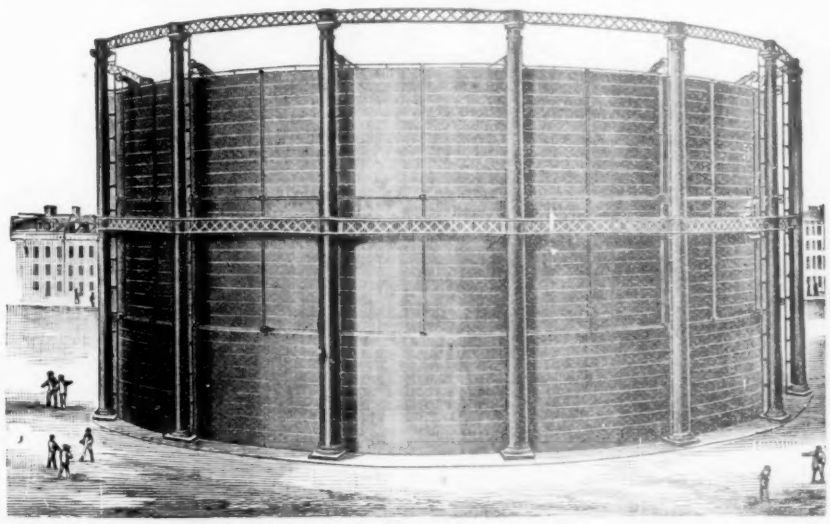

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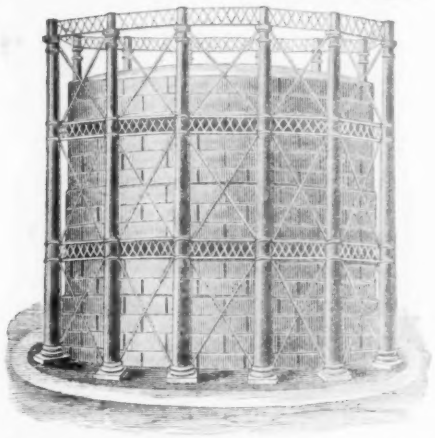

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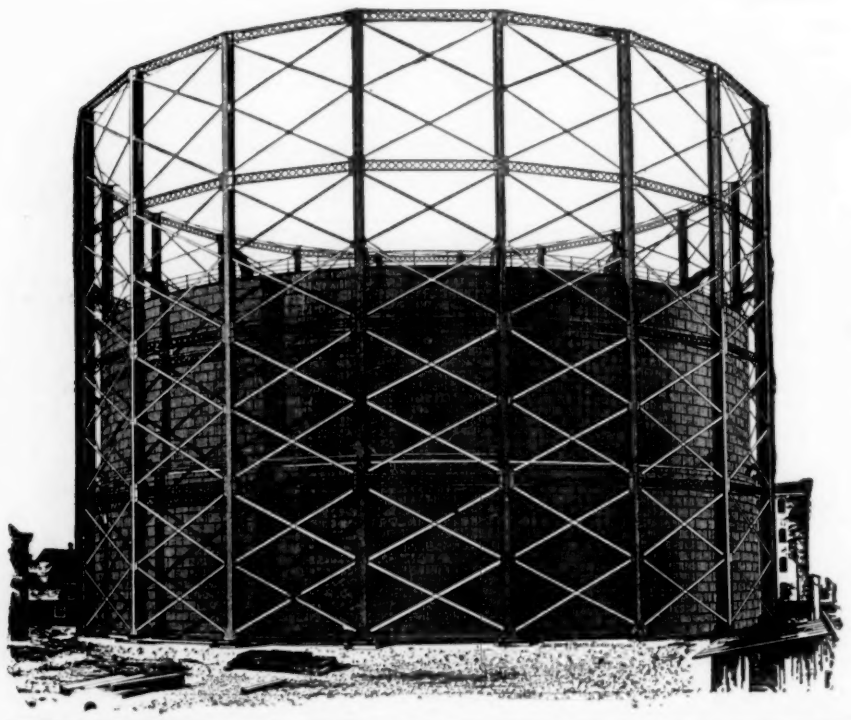

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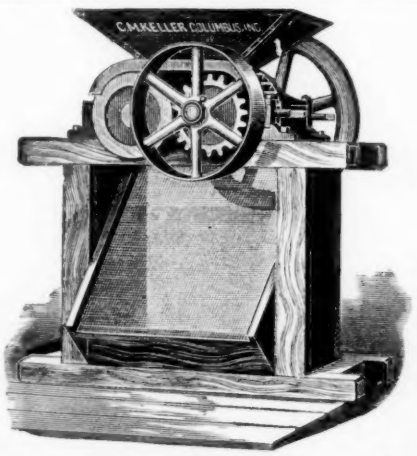

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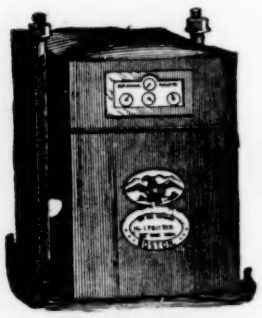

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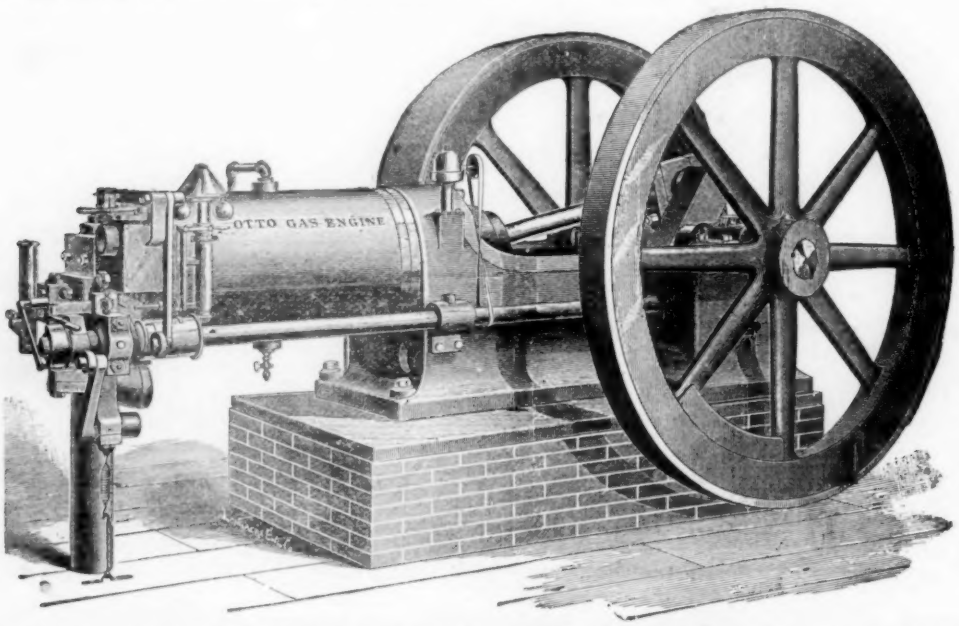

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